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International Journal of Cognitive Research in Science, Engineering and Education

(IJCRSEE)

EDITORIAL

International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE) is an open access international peer-reviewed, open-access journal, which provides a platform for highlighting and discussing various cognitive science issues dealing with the problems of cognition (and its evolution) within some specific subject field - philosophical, psychological, linguistic, mathematical, psychogenetic, pedagogical, ergonomic. Editorial Board strives to provide a possibility for the scientists of different fields to publish the results of their research, technical and theoretical studies. IJCRSEE is multidisciplinary in approach, and will publish a great range of papers: reports of qualitative case studies, quantitative experiments and surveys, mixed method studies, action researches, meta-analyses, discussions of conceptual and methodological issues, etc. IJCRSEE publisher is The Association for the Development of Science, Engineering and Education, Vranje, Serbia. Co-publishers are: University Business Academy, Faculty of Economics and Engineering Management in Novi Sad, Serbia and Don State Technical University, Rostov on Don, Russian Federation.

IJCRSEE particularly welcomes articles on the results of scientific research in various fields of cognitive science (psychology, artificial intelligence, linguistics, philosophy and neuroscience) catering for international and multidisciplinary audience. Readers include those in cognitive psychology, special education, education, adult education, educational psychology, school psychology, speech and language, and public policy.IJCRSEE has regular sections: Original Research, Review Articles, Studies and articles, Book Reviews, Case Studies, and is published three times a year. This journal provides an immediate open access to its contents, which makes research results available to the public based on the global exchange of knowledge. The journal also offers access to uncorrected and corrected proofs of articles before they are published.

The main aim of the Journal is to discuss global prospects and innovations concerning major issues of cognitive science, to publish new scientific results of cognitive science research, including the studies of cognitive processes, emotions, perception, memory, thinking, problem solving, planning, education and teaching, language and consciousness study, the results of studying man's cognitive development and the formation of basic cognitive skills in everyday life. The Journal seeks to stimulate the initiation of new research and ideas in cognitive science for the purpose of integration and interaction of international specialists in the development of cognitive science as interdisciplinary knowledge.

The International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE) is an international, peer-reviewed, open access journal that publishes original empirical and theoretical contributions at the intersection of cognitive science, education, psychology, and cultural studies. The journal aims to advance understanding of cognitive processes, learning and teaching, as well as cultural and social dimensions of education and knowledge.

IJCRSEE welcomes interdisciplinary research that explores how cognition, language, culture, media, and technology shape educational practices, learning environments, and identity formation in contemporary societies. By bringing together perspectives from cognitive psychology, pedagogy, linguistics, cultural studies, and related fields, the journal seeks to foster theoretically grounded and methodologically rigorous scholarship with clear implications for educational practice and policy.

The journal publishes:
- Original research articles
- Review articles
- Theoretical and methodological studies
- Case studies and monographic studies
- Book reviews

All submissions must be original, written in English, and are subject to a double-blind peer-review process.

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1. Cognitive Science and Psychology

- Cognitive science and cognitive processes (perception, attention, memory, learning, problem solving, planning, inference)
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2. Education, Curriculum and Learning Environments

- Cognitive research in education and educational psychology
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3. Cultural Studies, Media and Identity in Education

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- Identity, diversity and culture (class, gender, ethnicity, generation, nation)
- Digital culture and cultural practices in learning and socialization
- Cultural policy and governance in education and science
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4. Language, Text and Cognitive Technologies

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IJCRSEE provides a platform for academics and scientists professionals to refer and discuss recent progress in the fields of their interests. Authors are encouraged to contribute articles which are not published or not under review in any other journal.

Each submitted manuscript is evaluated on the following basis: the originality of its contribution to the field of scholarly publishing, the soundness of its theory and methodology, the coherence of its analysis, its availability to readers (grammar and style). Normal turn-around time for the evaluation of manuscripts is one to two months from the date of receipt.

Submission of an original manuscript to the journal will be taken to mean that it represents original work not previously published, that is not being considered elsewhere for publication; that the author is willing to assign the copyright to the journal as per a contract that will be sent to the author just prior to the publication and, if accepted, it will be published in print and online and it will not be published elsewhere in the same form, for commercial purposes, in any language, without the consent of the publisher.

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When considering submitting an article, the Editors have provided the following criteria to assist authors with preparing their submissions:

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Plagiarism - Content should be properly referenced. Be sure to check the paper for possible accidental plagiarism. Some plagiarism checker websites include: http://www.ithenticate.com/, www.antiplagiat.ru, www.grammarly.com, www.plagtracker.com or www.duplichecker.com

Writing – Please write in good English (American or British usage is accepted, but not a mixture of these). For non-native English speakers, and perhaps even for some native English speakers, grammar, spelling, usage, and punctuation of the texts are very important for an effective presentation. Hence, manuscripts are expected to be written in a clear, cogent, and readily understandable by an international readership.

Manuscripts must be submitted online. Electronic submission reduces the editorial processing and reviewing time. As part of the submission process, authors are required to check off their submission compliance with all of the following items, and submissions may be returned to authors who do not adhere to the following guidelines:

The submission has not been previously published or presented to another journal for consideration (or an explanation has been provided in Comments to the Editor).

The submission file is in OpenOffice, Microsoft Word, RTF, or WordPerfect document file format.

Where available, DOIs and URLs for the references have been provided.

The text is single-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.

The text adheres to the stylistic and bibliographic requirements outlined in the Author Guidelines.

If submitting to a peer-reviewed section of the journal, the instructions in Ensuring a Double Blind Review have been followed.

A manuscript goes through the peer review process. Authors submit manuscripts to Editorial office via the online system. The acknowledgement letter should be sent to the author to confirm the receipt of the manuscript. The Chief Editor first reviews manuscripts. Chief Editor is assisted by Section Editors (could also be Co- or Associated Editors). The Editor assigns a Section Editor to see the manuscript through the complete review process and return it with a recommendation or decision. The manuscript is checked to see if it meets the scope of the Journal and its formal requirements. If it is incorrect or unsuitable, the author should be informed and the manuscript filed (or returned if requested) – direct rejection. Manuscripts that are not suitable for publication in the Journal are rejected. A Rejection letter is sent to the author stating the reason for rejection. If the manuscript conforms to the aims and scope of

the Journal, and formally abides by the Instructions to Authors it is sent out for review. Depending on the type of paper, it could be accepted immediately for publication (invited Editorial, Book review etc) by the Chief Editor.

Check that the manuscript has been written and styled in accordance with the Journal style; that it carries an abstract (if applicable), keywords, correct reference system etc. and check that the correct blinding system has been used. If anything is missing ask the author to complete it before the manuscript is sent out for review.

The manuscript is sent out for review. The reviewer reads and evaluates the manuscript and eventually sends a review report to the Chief Editor. The time for review can be set to 2-6 weeks depending on the discipline (more time is usually given to papers in the humanities and social sciences). Make sure to provide the reviewer with clear instructions for the work, e.g. outlined in the form of a Review report or a number of questions to be considered.

Based on the reviewers' comments the Chief Editor makes a decision to:

- Accept the manuscript without further revision
- Accept after revision
- Ask authors to resubmit
- Reject

An acceptance letter is sent to the author and the final manuscript is forwarded to production. Sometimes, the authors are requested to revise in accordance with reviewers' comments and submit the updated version or their manuscript to the Chief Editor. The time for review can be set to 2-6 weeks depending on the discipline and type of additional data, information or argument required. The authors are requested to make substantial revisions to their manuscripts and resubmit for a new evaluation. A rejection letter is sent to the author and the manuscript is archived. Reviewers might be informed about the decision.

After review a manuscript goes to the Copy Editor who will correct the manuscript concerning the correct referencing system, confirmation with the journal style and layout. When Copy Editor finishes his/her work they send manuscripts to the Layout editor.

Layout Editor is responsible for structuring the original manuscript, including figures and tables, into an article, activating necessary links and preparing the manuscript in the various formats, in our case PDF and HTML format. When Layout Editor finishes his/her job they send manuscripts to Proof Editor.

Proof Editor confirms that the manuscript has gone through all the stages and can be published.

This issue has 18 articles (16 Original researches and 2 Review articles). Our future plan is to increase the number of quality research papers from all fields of science, engineering and education. The editors seek to publish articles from a wide variety of academic disciplines and substantive fields; they are looking forward to substantial improvement of educational processes and outcomes.

Editor in Chief
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The Impact of an Informatics-Developmental Teaching Approach in the Subject Nature and Society on Students' Motivation

Ljiljana Bujišić[1], *Gordana Miščević*[1], *Danimir Mandić*[1*], *Ivan Kostadinović*[2]

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Abstract: In this study, we examined the extent to which implementing an informatics-developmental teaching approach with e-learning in the Nature and Society course influences student motivation. The motivation level of ten-year-old students was assessed before and after implementing this instructional approach, comparing an experimental group (innovative instruction) to a control group (traditional approach). The research was conducted using a parallel-groups experimental design on a sample of 189 fourth-grade primary school students. In the experimental group, the subject was taught following an informatics-developmental model using digital technologies (tablets, multimedia content, gamification elements), while the control group was taught using a traditional approach. Student motivation was measured with an adapted Likert scale before and after the intervention. Data were analyzed with descriptive statistics, independent and paired-samples t-tests. Before the experiment, no significant difference in motivation was found between the two groups. At the final measurement, the experimental group had a statistically significantly higher level of motivation than the control group. The findings confirm that innovative, digitally supported instruction can enhance students' learning motivation compared to traditional methods. The contemporary approach fostered greater student engagement and interest, which was reflected in a rise in their motivation. It is recommended to more broadly implement digitally enriched instructional strategies in primary schools to stimulate student motivation. It is also necessary to provide continuous professional development for teachers for effective integration of ICT in instruction. Future research should consider the long-term effects of such innovations and their impact on various educational outcomes.

Keywords: *informatics-developmental teaching, student motivation, digital technologies in education, Nature and Society, primary school, artificial intelligence.*

Introduction

Traditional elementary school teaching, which is lecture-based and identical for all students regardless of their individual needs and capacities, is increasingly showing significant shortcomings relative to the modern demands of education. Criticisms of this approach include the uniform pace of instruction and content that are not adapted to the diverse speeds, interests, and learning styles of all students. Instead of deep understanding, students often study for grades, which leads to insufficiently developed competencies that they will need in their future. In simple terms, the traditional education system does not provide an adequate foundation for developing the competencies required by contemporary students, which is why fundamental changes are necessary.

From the earliest childhood, through exploration and discovery of the world, a child builds their own understanding of the environment, and starting school represents a significant turning point in that process—not only for the child but also for the family—since the teacher and peers enter the educational context as new actors. Contemporary educational trends, which are rapidly changing, necessitate innova-

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tive approaches in teaching, especially in subjects such as *Nature and Society*, which provide a broad scope for applying information and communication technologies to encourage student development and understanding of the world. Among students entering secondary education, a tendency of declining motivation has been observed (Chouinard, Roy, Archambault, and Smith, 2017; De Bruijn, Ehren, Meeter, and Kortekaas-Rijlaarsdam, 2025). Therefore, researchers highlight the necessity to examine the causes of this issue within the context of earlier schooling, particularly the manner in which instructional activities are conducted in primary school. Developing interest and motivation at that stage provides the basis for an individual's later personal and professional development. An individual's active participation and engagement in society will play a crucial role in a future increasingly characterized by scientific and technological advancement.

Theoretical Framework

Informatics-Developmental Teaching and the Zone of Proximal Development

A. Diesterweg, a 19th-century German pedagogue, laid the groundwork for *developmental learning* by emphasizing the importance of independent student work in the teaching and educational process. L. S. Vygotsky formulated the theoretical basis of developmental instruction through his interpretation of the relationship between learning and development, which became the foundation for further research by his followers. D. B. Elkonin developed a strategy in which he stressed the significance of instructional content as a driver of students' intellectual development, building on Vygotsky's model. L. V. Zankov contributed to the development of teaching practice by introducing dynamic changes in working methods, focusing on the comprehensive development of students. V. V. Davidov, in contrast to the empirical orientation of Zankov's team, argued that knowledge develops through classification, comparison, and abstract thinking (Davidov, 1995; Elkonjin, 1990; Bujišić, 2023). In that context, contemporary instruction strives to transcend the patterns of the traditional approach, not by discarding its valuable elements but by reinterpreting them toward fostering student development through exploration, sensory experience, and rational thinking. Existing literature indicates a wide spectrum of information on traditional teaching and its limitations, while empirical evidence on the informatics-developmental model is limited. Traditional teaching is positioned as a model based on "ready-made" knowledge that teachers transmit, expecting students to reproduce it — the lowest level of cognitive skills. Modern authors advocate a competency-based educational system that values understanding, application, and reasoning, and develops digital and algorithmic literacy, along with inclusiveness and personalization in learning. In contrast to traditional, passive instruction, contemporary authors stress that students should actively engage in constructing knowledge rather than merely memorize it (Nikolić, 2019; Bujišić, 2023; Mandić, Miščević, Babić, and Matović, 2024). In informatics-developmental instruction, tools and a supportive environment are used to place the student in the role of a researcher, which in turn increases motivation to learn because the learning is carried out in a modern way and influences other aspects of the student's personality (Bujišić, 2023). One possible solution that can overcome the observed shortcomings of traditionally conceived instruction is the informatics-developmental approach. It integrates digital competencies as part of a comprehensive educational process. Informatics-developmental instruction is a modern teaching model grounded in a heuristic approach and the use of information and communication technologies. This model enables students to construct knowledge independently, progress at their own ability level and pace, and develop their personal potential. Through an individualized and interactive approach, it also improves the quality of learning and collaboration in the educational environment (Bujišić, 2023). In Serbia, the subject *Digital World* has been introduced in the first and second grades of primary school, and digital competencies are included in the current *Years of Ascent* Preschool Curriculum Framework (Matović and Ristić, 2024; Years of Ascent Preschool Curriculum Framework Serbia, 2019). *The Strategy for the Development of Artificial Intelligence in the Republic of Serbia for 2025–2030* outlines plans to advance primary, secondary, and higher education in Serbia in the field of artificial intelligence. Moreover, student digital literacy—developed within formal education as a cross-curricular competency and within informatics education as a subject-specific competency—is mandated by strategic and program documents (Mandić, 2023; The Strategy for the Development of Artificial Intelligence in the Republic of Serbia for 2025–2030, 2025; Strategy for the Development of Digital Skills in the Republic of Serbia for the period 2020 to 2024, 2020). Modern educational technology, based on artificial intelligence (AI), is changing teaching methods and

organisation toward heuristic learning and active students participation. Teachers are not delivering final knowledge so students are using several didactical resources, including AI, to develop their own concepts. Developmental teaching approach increases critical thinking, reflection and self-reflection in new concept of educational technology.

Considering a social-constructivist approach, it is important to highlight L. Vygotsky's theory of the *zone of proximal development* (ZPD), in which students, through social interaction, take on and internalize ways of thinking and methods that they will later use independently, with tasks that are challenging enough to spur progress but not so difficult as to demotivate the learner. In collaboration with others, a child can achieve more than they can alone – but only up to the limits allowed by their developmental maturity and intellectual abilities (Vygotsky, 1978). In Vygotsky's theory, the competent person who actively helps the learner can be a teacher or a more advanced peer, actively stimulating interest, providing structured help by demonstrating effective strategies and reducing task complexity, thereby preventing cognitive overload. Over time, the student progresses and becomes increasingly independent, and support is gradually withdrawn. Research on integrating AI tools into higher education using the ZPD framework found that AI tools enable students to self-assess their progress, increase motivation and engagement, and build knowledge collaboratively—resulting in better academic performance and personal development (Cai, Msafiri, and Kangwa, 2025). Although modern educational technology is not literally an "advanced" peer or adult, in Vygotsky's sense it has the potential to significantly support students within their ZPD. Through adaptive personalization, dynamic support, and timely feedback, technology enables learning tailored to individual student needs. It facilitates collaborative and peer learning activities via various digital tools and platforms. Even relatively simple, expert AI systems can perform certain scaffolding functions (Sætra, 2025). They allow the application of various forms of *scaffolding*—conceptual, procedural, strategic, and metacognitive—thus supporting the development of meaningful schemata of understanding. Artificial intelligence and learning analytics function as cognitive tools which, together with the teacher as designer, ensure creative, adaptive, and goal-driven development of technology-enhanced learning scenarios within the ZPD (Rigopouli, Kotsifakos, and Psaromiligkos, 2025). In addition, technological tools adjust the learning pace and gradually redirect students towards greater autonomy, promoting the development of self-regulation and critical thinking. With such an approach, the student, through gradual self-reliance, becomes more competent in managing their own learning process, while technology—although not a substitute for social interaction with an adult—serves as a cooperative ally in learning.

Importance of Motivation for Learning

Motivation is examined in behaviorist, humanistic, cognitive, and other theoretical frameworks; behaviorism highlights the role of external reinforcements, cognitivism focuses on internal mental processes and personal goal evaluations, and social factors significantly affect the development of self-assessment and the shaping of students' learning motivation. It is a psychological process that initiates, directs, and maintains our activities toward achieving a specific goal, and it is permeated by enthusiasm and determination to reach that goal through the initiation and maintenance of proactive behavior (Bandhu et al., 2024; Pekrun, 2024). Motivation can originate internally—from the desire for enjoyment, personal development or accomplishment—or externally, through rewards, recognition, or external expectations. Students who study because something genuinely interests them or because they want to succeed achieve better results than those who learn only due to external rewards or pressures (Šafranj, Bulatović, and Gak, 2024). Artificial intelligence can become a powerful motivational accelerator and a source of competency-based achievements for students, not by replacing the teacher but by supporting them so that each child progresses more independently, with greater interest and confidence in their own abilities (Mandić, Miščević, and Bujišić, 2024; Mandić, Miščević, and Ristić, 2025; Miščević, Starijaš, and Petrović, 2025). Thus, when the opportunities offered by the use of AI are employed with careful design, it can lead to fulfilling students' psychological needs. Effective models need to incorporate the following components: adaptive systems pre-adjusted to the students' ability level; opportunities for students to participate in the choice of learning activities; a visually rich and comprehensible interface adapted to the students' age; real-time constructive feedback. All of the above should be implemented with teacher support, in an inclusive and ethically responsible manner. When AI capabilities are combined with careful pedagogical design, models can include adaptive systems tailored to student ability, allow students some choice in activities, offer age-

appropriate visual interfaces, and provide real-time constructive feedback—all under teacher guidance to ensure inclusivity and ethical use.

Materials and Methods

The aim of this research is to determine how the implementation of electronic learning in informatics-developmental instruction of *Nature and Society* classes affects student motivation by comparing their motivation before and after an experimental program in the experimental and control groups. The task is to examine the level of motivation for learning about nature and society among students in the experimental and control groups during Nature and Society classes before and after the implementation of the experimental program. The hypothesis states that students in the experimental group, after the application of informatics-developmental instruction, will exhibit a significantly higher level of motivation for learning *Nature and Society* compared to students in the control group who have used a traditional approach.

The independent variable is the teaching method: the experimental group was taught *Nature and Society* using an informatics-developmental approach supported by e-learning (encompassing computerization, interactivity, constructivism, heuristic methods, self-evaluation, and appropriate technical equipment), whereas the control group was taught using a traditional approach. The dependent variable is students' motivation for learning about nature and society, measured as a summative score on a five-point Likert scale before and after the intervention.

We employed a parallel-groups experimental design to investigate the effect of informatics-developmental instruction on student motivation. The measurement instrument was a motivation scale constructed for this purpose, administered before and after the intervention. The instrument demonstrated high objectivity (Pearson r = .99 for agreement between two independent raters) and an acceptable level of reliability, with Cronbach's α ranging from .69 to .72 for the experimental and control groups at the initial and final measurements. The study was conducted over four months within regular classes, during which motivation was measured at the beginning and at the end.

The sample of participants consisted of four control classes and four experimental classes of students from Belgrade (Serbia), totaling 189 fourth-grade students. The sample of instructional content covered the teaching topic "Natural and Social Features of Serbia" from the fourth-grade *Nature and Society* curriculum.

The experimental and control groups were equated based on two variables: approximately the same number of students and the classes' average grade in *Nature and Society* at the end of the previous school year. The groups did not differ statistically significantly, as evidenced by a t-test, $t(189) = –0.67$, $p > .53$.8

Data were processed using the SPSS statistical package (version 23.0). We used the following statistical analyses:

- Descriptive statistics – including arithmetic mean, standard deviation, minimum and maximum score, skewness, and kurtosis.
- Cronbach's alpha coefficient – to assess the reliability of the motivation scale instrument.
- Independent-samples t-test – to measure differences in motivation for learning *Nature and Society* between the experimental and control groups.

Results

Table 1. *Descriptive statistics and differences between experimental and control groups on the initial motivation test (independent-samples t-test)*

Group	Min	Max	M	SD	S	K	*t*	*df*	*p*
EG (Experimental)	5	23	14.14	5.24	–0.02	–1.29	1.74	187	0.084
KG (Control)	5	25	15.45	5.08	–0.11	–1.08			

Note. EG = experimental group; KG = control group; M = mean (arithmetic mean); SD = standard deviation; S = skewness; K = kurtosis; t = t-test; df = degrees of freedom; p = significance level

After introducing the experimental factor—the informatics-developmental teaching approach in *Nature and Society* classes—the next step was to measure the differences between the experimental and

control groups at the final measurement of motivation, as presented in the following table.

Table 2. *Descriptive statistics and differences between experimental and control groups on the final motivation test (independent-samples t-test)*

Group	Min	Max	M	SD	S	K	*t*	*df*	*p*
EG (Experimental)	5	25	16.13	5.30	–0.22	–0.80	–2.83	187	.005
KG (Control)	5	25	14.03	4.90	0.12	–0.63			

Note. EG = experimental group; KG = control group; M = mean; SD = standard deviation; S = skewness; K = kurtosis; *t* = t-test; *df* = degrees of freedom; *p* = significance level.

Table 3. *Differences between the experimental and control group on the initial and final motivation tests (independent-samples t-test)*

Group	Measurement	M	SD	*t*	*df*	*p*1	*r*	*p*2
EG (Experimental)	Initial test	14.14	5.24	–2.95	90	.004	.25	.015
EG (Experimental)	Final test	16.13	5.30					
KG (Control)	Initial test	15.45	5.08	2.16	97	.034	.15	.144
KG (Control)	Final test	14.03	4.90					

Note. EG = experimental group; KG = control group; M = mean; SD = standard deviation; *t* = t-test; *df* = degrees of freedom; *p*1 =significance level of the t-test for that group's pre–post difference; *r* = Pearson correlation coefficient between values from the first and second measurement; *p*2=significance level of the Pearson correlation coefficient.

Discussion

Based on the data from Table 1, the students in the experimental group obtained slightly lower scores on the initial motivation test compared to the students in the control group. The score range in the experimental group was from Min = 5 to Max = 23, while in the control group the range was somewhat broader—from Min = 5 to Max = 25. The average score of the experimental-group students (M = 14.14, SD = 5.24) was lower than the average score achieved in the control group (M = 15.45, SD = 5.08). An independent-samples t-test showed that the difference in mean motivation scores between students in the experimental and control groups was not statistically significant, $t(187) = 1.74$, $p > .05$. Therefore, prior to the introduction of the experimental factor, the level of motivation for learning *Nature and Society* was similar in both groups. In the experimental group, skewness (S = –0.02) did not indicate any significant departure from a normal distribution, whereas the kurtosis (K = –1.29) suggests a platykurtic (flattened) distribution, consistent with normality. A similar observation applies to the control group: skewness (S = –0.11) did not indicate any significant horizontal deviation, while kurtosis (K = –1.08) appeared to reflect a somewhat uniform distribution of scores (a leptokurtic profile). Based on these results, it can be concluded that the experimental and control group students demonstrated an equivalent level of motivation for learning *Nature and Society* on the initial test.

How this motivation develops further depends on teacher competencies, numerous variables in the student's environment, and the student's personal characteristics. We note here Davis's Technology Acceptance Model (TAM), which emphasizes that perceived usefulness and perceived ease of use decisively determine the acceptance of technology, as they shape the user's attitude and motivation toward actual use (Davis, 1989). In an educational context, students are more motivated to adopt modern information technologies when they perceive that these technologies will help them learn and are intuitive to use. Motivation, in the form of technological self-efficacy, has been identified as one of the key external variables that significantly contribute to user satisfaction, thereby expanding TAM's explanatory power (Latif, Saputro, and Barkah, 2025). Huang and Yang (2025) likewise recognize motivation as a subtle yet crucial element that complements the classic determinants such as perceived usefulness and ease of use, reinforcing the educational acceptability of information technologies by guiding students toward intention and actual application.

The results presented in Table 2 indicate that students in the experimental group achieved significantly higher average motivation scores compared to students in the control group. Specifically, the average

score of the experimental group was M = 16.13 (SD = 5.30), whereas the average score of the control group was M = 14.03 (SD = 4.90). An independent-samples t-test confirmed that the difference between the mean motivation scores of the experimental and control groups was statistically significant. In the experimental group, skewness was not statistically significant (S = –0.22), further confirming the normal distribution of results; similarly, the kurtosis (K = –0.80) was not significant, which also suggests a normal distribution. The control group shows similar tendencies – neither skewness (S = 0.12) nor kurtosis (K = –0.63) indicates any deviation from normality. Babić and Matović (2025) emphasize that reliably integrating AI into education, with an optimal balance between teacher control and automation, requires proactive educational measures that can indirectly strengthen student motivation by providing a safer and more supportive technological environment. On the other hand, Stoković (2025) notes that incorporating educational robots into teaching develops algorithmic thinking and motivates students through practical problem solving, where the process of discovery and correcting mistakes becomes a key pedagogical incentive.

The data from Table 3 indicate that the control group experienced a decline in the average motivation score. On the final test, the control group's students (M = 14.03, SD = 4.90) scored lower than they did on the initial test (M = 15.45, SD = 5.08), and the difference between the initial and final measurements, with $t(97)= 2.16$, was not statistically significant at the $p < .05$ level. In the experimental group, by contrast, a significant increase in motivation scores was observed. On the final test, the experimental group's students (M = 16.13, SD = 5.30) achieved higher scores than on the initial test (M = 14.14, SD = 5.24). The difference between the initial and final measurements, with $t(90)= –2.95$, was statistically significant at the $p < .05$ level. For successful student motivation through ICT integration, it is necessary to devote equal attention to the school context (especially students' perceived usefulness of technology and teacher support) and to a stimulating home environment that fosters self-confidence and motivation (Huang, Gao, Kim, and Ohno, 2025).

In the final consideration of our hypothesis, it can be concluded that introducing informatics-developmental instruction has a positive impact on student motivation. Namely, the students in the experimental group, after the implementation of the given instructional method, demonstrated a statistically significantly higher level of motivation for learning the subject *Nature and Society* in comparison to the students in the control group, whose teachers relied on a traditional approach. The didactic-methodical component encompassed the application of information technology tools in accordance with the learning objectives and outcomes, as well as the use of ICT for active, problem-based, and project-based learning, and the individualization of instruction through the adaptation of pace and complexity to the learner's needs. Furthermore, it emphasized the affirmation of the teacher's role as a facilitator and mentor rather than a traditional lecturer, the encouragement of problem-solving and creative idea generation through technology, the promotion of collaborative learning via digital tools, and the monitoring of student progress through digital assessment instruments.

Conclusions

The results of this research unequivocally show that the implementation of informatics-developmental instruction — which integrates digital tools and contemporary pedagogical methods — has a significantly positive impact on student motivation. A detailed interpretation suggests that the rise in motivation in the experimental group was a direct result of the well-designed pedagogical approach: students were provided with interactive and multimedia content appropriate to their age, along with the use of tablet computers and gamification elements (points, badges) that were carefully implemented. Such content made the material more interesting and accessible than in traditional teaching, which encouraged greater student engagement.

At the same time, the teachers organized learning within the students' zone of proximal development (ZPD) — each student was assigned tasks slightly above their current abilities, but these tasks were made achievable with initial support from a more capable partner (the teacher, a peer, or AI), and subsequently the student became able to solve them independently with the aid of technology and interactive guidance. This gradual transition from guided to independent activity increased the students' self-confidence and sense of accomplishment, which strongly contributed to the rise in motivation.

Implications for educational practice include:

- **Pedagogy over devices:** The mere availability of digital devices is not sufficient — the teacher's pedagogical creativity and competence in designing ICT-supported activities are crucial for success.
- **Teacher as mentor:** In the digital classroom, the teacher's role shifts from lecturer to mentor. The teacher should select appropriate digital tools, design interactive learning tasks, and guide students so that technology is used to achieve educational goals rather than serve as mere entertainment.
- **Teacher competencies:** A teacher's digital literacy and willingness to innovate directly influence the creation of a motivating classroom atmosphere.
- **Professional development:** It is essential to invest in continuous professional development for teachers to effectively implement modern instructional models and educational technologies.

In the broader context of digital education, these results provide empirical support for efforts to transform traditional teaching through thoughtful use of technology. The increased student motivation observed in this study corresponds to theoretical models of technology acceptance in education, which highlight that the usefulness and interactivity of educational technologies lead to more positive student motivation to learn. A practical consequence is that schools that strategically introduce digital platforms and resources—accompanied by adequate pedagogical support—can expect to have students who are more engaged and more ready for active learning. These results are also consistent with national strategies for the digitalization of education – they show that the integration of ICT, when accompanied by thoughtful pedagogy, can improve teaching quality and increase student motivation, which is important for developing the digital competencies of younger generations.

Finally, it is important to emphasize that this research is only a beginning in understanding the complex relationship between technology, pedagogy, and motivation. We recommend that future studies investigate the long-term effect of informatics-developmental instruction on sustaining student motivation over extended periods, as well as its impact on other educational outcomes such as academic achievement, critical thinking, and the development of 21st-century skills. It would also be beneficial to analyze how different factors—for example, the level of parental support or students' prior experience with technology—might modify the effect of such interventions. By further expanding research to different age groups, subject areas, and inclusive educational settings, we can gain a more complete picture of how digitally enriched teaching can contribute to improving educational processes. In this endeavor, teachers will continue to have a key role as agents of change; empowered with digital competencies and didactic knowledge, they can shape the future of education in accordance with the needs of contemporary society.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, LJ.B.; methodology, LJ.B.; software, D.M.; formal analysis, G.M. and LJ.B.; writing—original draft preparation, LJ.B.; writing—review and editing, LJ.B, G.M., D.M.; Data curation LJ.B.; Formal analysis G.M. and LJ.B.; Funding acquisition LJ.B. and D.M.; Investigation LJ.B. and G.M.; Project administration LJ.B. and G.M.; Resources LJ.B; Supervision D.M., G.M and I.K.; Validation LJ.B.; Visualization I.K.

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Designing Language Activities for Young Learners Based on Human and AI-generated Stories

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Abstract: The article presents the results of a study conducted among novice teachers of English language, trained at two major universities in Bulgaria. The objectives of the study were: 1) to evaluate the extent to which students perceived stories, authored by human and artificial intelligence, as applicable in educational context; 2) to gain an insight into their competence to design story-based language learning activities for preschool and primary school children; and 3) to seek possible relations between their teaching competence, language proficiency levels, skills to use AI-tools and their perceptions of the usefulness and practical classroom application of the two types of narratives. Results showed that students viewed both types of texts as useful in foreign language teaching, but the displayed degree of usefulness was stronger for the AI-generated one. A tentative explanation of this finding could be the capacity of ChatGPT as a large language model to mimic human linguistic production fairly convincingly. Overall, students exhibited a reasonably high degree of understanding of language learning as a collaborative experience and showed abilities to apply interactive approaches and techniques in the activities they proposed. The higher the teaching competence of the participants, the stronger their awareness of the various interdisciplinary links a teacher can make in their language classes to other fields of knowledge. This is a promising indication for the capacity of teachers to capitalize on the affordances of story-based language learning and interweave cross-curriculum references in their teaching practices which brings added value to the learning process.

Keywords: *early language education, stories, activity design, artificial intelligence.*

Introduction

The present study is part of a large research project launched among university students from different teacher training programmes at two Bulgarian universities - Sofia University "St. Kliment Ohridski" and New Bulgarian University, aimed at exploring different aspects of the use of stories, generated by human and artificial intelligence (AI), in language education. This study seeks to ascertain the potential applicability of AI-created narrative texts in story-based language teaching practices. Designing activities, the contents of which stem from engaging stories, to achieve specific language learning purposes that are tailored to the needs of particular young learners, is at the core of interactive, learner-centered language classrooms.

Early language learning encompasses cognitive, affective and social aspects. Holistic approaches to teaching languages to children aim at engaging the entire personality of the child by devising communicative opportunities that promote the use of the target language (Cameron, 2001; Pinter, 2017). Continued and meaningful input in the target language (Gass and Mackey, 2015) fosters acquisition as it provides a communicative environment where learners, under gentle guidance, explore a new linguistic reality and gain self-confidence.

Language teaching practices that ensure an ongoing exposure of learners to the target language at a level surpassing their current output fluency prove beneficial for sustainable language progress (Terzioğlu and Kurt, 2022). Instruction styles that encourage learners' efforts to step beyond the current limit of lin-

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guistic resources available to them (Gass and Mackey, 2015) provide a safe learning space for progress. It should also be noted here that frequent encounters with lexical and grammatical items facilitate their acquisition by young learners. A particularly efficient technique is the provision of a variety of contexts or discursive opportunities where these items are utilized (Cameron and McKay, 2013). Additionally, creating diverse opportunities to communicate in the target language adds substance to incidental lexical gains (Cameron, 2001).

Stories provide an engaging context for language learning (Harizanova, 2020). Research shows that primary school children are better able to comprehend fiction narratives in comparison with nonfiction texts (Chung et al., 2023). This finding is corroborated by viewing the language of stories as representational rather than merely referential (Hsu, 2015). Lexical units and syntactical structure make better sense and are easier to retain (Godwin-Jones, 2018) when placed in a cognitively and emotionally appealing contextual frame (Ghafar, 2024; Goodger, 2025). This is further supported by evidence, suggesting that discursive practices in language classrooms step onto context as "the locus of language" (Dodigovic, 2005: 4). Practices in early language teaching incorporating short narratives assist language acquisition by "increasing word knowledge or introducing different sentence patterns" (Hadaway and Young, 2010: 45). Stories have been acknowledged to help increase children's vocabulary range and awareness of sentence structure (Mukherji and O'Dea, 2000) in their mother tongue as well. Furthermore, stories are also deemed to enhance oral production (Arias, 2017) as they exemplify specific language patterns that young learners employ with a growing confidence in their own language output.

In the early stages of learning a foreign language, listening and speaking skills are the focus of instruction (Arnold and Rixon, 2011). Listening to engaging narratives not only develops awareness of phonological characteristics of the target language but also supports comprehension of word meanings (Valentini et al., 2018; Read and Soberón, 2020). Findings from a study among preschool children indicate that listening to stories is "beneficial to the development of oral language complexity and story comprehension in young children" (Isbel et al., 2004: 161).

Findings from research among Taiwanese preschool children (Hsu, 2015) show that engaging plots stimulate critical thinking skills and, additionally, keep learners with shorter attention spans interested in the activity, provided that teachers ensure continued constructive guidance. Further to that, well-designed language learning activities streamline the overall structure of pedagogical interventions (Littlejohn, 2011). These observations are consistent with the view that vocabulary acquisition occurs not through direct instruction but rather through communicative exchanges which situate lexical uses in a specific context (Elley, 1989). The power of the spoken word is further exemplified in the claim that children at primary school are better able to understand the meanings of new words when listening to stories rather than when reading them (Valentini et al., 2018: 11). Research has shown that conversations with young learners as part of interactive read-alouds enable incidental word learning (Cole et al., 2017) as the contextual framework helps children infer the meanings of unfamiliar lexical items (Elley, 1989).

Story-based language activities are particularly effective when performed collaboratively since teamwork can foster communication and enhance learners' creativity and problem-solving skills. Collaborative learning and group activities have been evidenced to improve the language progress of both individual learners (Whong, 2011) and the entire group (Moskovkin and Shamonina, 2020). Practising the language in small groups provides a safe environment where learners are encouraged to rely on already accumulated knowledge (Cole et al., 2017) and scaffold their skills for social cooperation and joint decision making. Learning is supported by the interactive incorporation of various sensory prompts, physical movement and meaningful references to children's own prior experience (Goodger, 2025). Further to that, language learning activities that foster cooperation, celebration of achievement and inclusion impact learners' confidence and, more importantly, provide a learning environment where children feel safe to take risks in their linguistic output (Vygotsky, 1978; Cameron, 2001; Cameron and McKay, 2013). Some recent studies suggest that there are also ensuing linguistic benefits from a more active social engagement with peers while taking part in language learning activities (Ghafar, 2024).

Language teachers can devise warm-up and/or follow-up activities, based on stories, that aim at revising or introducing new linguistic content. It is through well-designed, insightful and fun activities that young learners can be engaged in using the target language (Read, 2007; Goodger, 2025). Providing children with diverse contexts for language use empowers them to achieve a "more fluent automatic production" (Gass and Mackey, 2015: 185). To further promote linguistic output, it is considered beneficial

to vary the communicative setting of language-learning activities, thus challenging learners to experiment with their communicative abilities (Daniel, 2012), as well as to expand the range of linguistic resources they employ (Cameron and McKay, 2013; Gass and Mackey, 2015). As learners gain confidence in their language progress, it would be worthwhile to engage them in activities aimed at an independent generation of contextual cues (Wen, 2021).

When designing a learning activity suited to learners' needs, educators first consider specific teaching goals and expected outcomes. In the light of current learner-oriented teaching practices, it is of even greater importance to focus activities on language-learning purposes that are "clear and meaningful" (Moon, 2000: 88) for the learners themselves. Young children are eager to make sense of activities they are invited to take part in, and it is this strive to construct meaning which can effectively be put into action in language learning (Cameron, 2001).

The clear narrative structure of stories for young children provides a sustainable model for young learners, which supports a syntactically complicated (Brinton and Fujiki, 2017) and logically consistent output, thus laying solid foundations for the development of narrative skills. Storytelling activities can help reinforce grammatical structures (Fojkar et al., 2013; Arias, 2017) and enhance language complexity (Isbel et al., 2004). Compared to participation in conversational exchanges, attempts at producing an oral narrative pose a much greater challenge to young learners' abilities to plan and control their linguistic production (Nicolopoulou, 2017), which nurtures the development of reflection-on-action learner strategies and learner agency, i.e. "the feeling of ownership and sense of control that learners have over their learning" (Larsen-Freeman et al., 2021: 6).

The present study is also underpinned by the understanding that situates language teaching within the broader framework of educational values for children's overall development (Arnold and Rixon, 2011). Therefore, language classroom practices which expand functional language goals to include the fostering of skills and knowledge that formally belong to other subject areas or fields of learning (Richards and Rogers, 2014) cultivate sustainable, meaningful and engaging pedagogical interactions. Designing language learning activities that endorse skills and concepts from other domains of knowledge (Daniel, 2012; Mukherji and O'Dea, 2000) and develop associative thinking abilities (Bland, 2021) adds value beyond the specific language-related goals of instruction. Additionally, language teaching is inherently meant to equip learners with competencies for intercultural communication (Dimitrova-Gyuzeleva, 2019). Authentic short narratives can be effectively employed in language teaching to develop learners' intercultural awareness (Mukherji and O'Dea, 2000; Russel and Murphy-Judy, 2020; Bland, 2022).

Results from a survey among primary school language teachers in Turkey (Çakir, 2015) indicate that teachers may be unwilling to develop their own instructional materials or activities for reasons related to curriculum content, time constraints, or lack of sufficient confidence in using digital technologies. Another study, conducted among primary school language teachers in Slovenia (Fojkar et al., 2013), suggests that time constraints come again to the fore when instructors need to choose between adapted and authentic short stories, as well as between pre-created and self-created accompanying activities. We believe it would be worthwhile to research language teaching practices in Bulgarian educational settings for young children to gain insights into the degree to which language teachers feel confident and competent to apply interactive approaches and activities of their own design.

With regard to the rapid technological advancement that educational practices nowadays avail of, it would be pertinent to acknowledge the growing evidence of artificial intelligence (AI) tools' usability for complementing language learning (Sarwari et al., 2024; Woo et al., 2024). Educators' choices of how to incorporate AI applications in teaching can benefit from precepts governing the usage of educational technology, such as "the educational value of the tools and applications […], how adequate they are in the acquisition of knowledge, whether there is an interaction between users and tools" (Stošić, 2015: 112). In the field of language instruction, generative AI is deemed to be of useful assistance to language educators as regards the development of learning materials and tasks (Öksüz Zerey, 2025). Moreover, AI systems can "gamify the classroom" (Shah, 2023: 170) by suggesting entertaining activities that either serve to achieve particular educational purposes or ensure a more relaxed learning environment. Our study followed the line of thinking suggested by Murphy (2019) that AI systems or applications are currently better suited for generating predictable and less varied tasks, while complex ones are more efficiently designed by humans (Chang and Kidman, 2023).

From the perspective of inclusive education, there is growing evidence that AI systems can "cre-

ate tailored educational content" (Damyanov, 2024: 18) that takes into account diverse learning styles and needs. Additionally, the capacity of AI tools to provide personalized feedback on learners' progress (Baltezarević and Baltezarević, 2024) has been increasingly acknowledged. Research findings also suggest that AI technologies can be effectively used to promote collaborative learning (Luckin et al., 2016) and conversational practices (Godwin-Jones, 2024). Therefore, implementing AI tools in educational contexts calls for strong awareness on the part of educators of the ethical aspects of AI use (Shah, 2023; Damyanov, 2024; Pack and Maloney 2024). Specific ethical concerns have been raised regarding the degree to which AI technologies are tailored to meet the developmental needs of young children (Berson et al., 2025).

Although there is a lot of research on the value of using stories to facilitate early language acquisition and support children's general cognitive development, as well as on the learning affordances of educational technology, to our knowledge there have been no studies conducted to ascertain the potential applicability of AI-created narrative texts in story-based language teaching practices. The present study aimed to prove that AI-generated stories are as good as those created by human authors and can effectively be used in educational contexts, saving teachers a lot of time and effort in creating additional teaching materials.

Theoretical background of the study

The present study steps onto the sound theoretical and practical rationale of research on learning in the early years and early language acquisition, on the one hand, and the usability of AI-generated textual output in language instruction, on the other.

Socio-cultural theory and the concept of the Zone of Proximal Development

Our survey is underpinned by the constructivist perspective in education, which calls for active learning and positions the learner at the centre of the educational process. It is the basic tenet of the socio-cultural theory and underlies the concept of the Zone of Proximal Development proposed by social constructivist Lev Vigotsky (1978, 1997). According to Vygotsky, cognitive growth in childhood is enhanced by interaction with and assistance from a skilled instructor or another significant adult. The Zone of Proximal Development (ZPD) is hypothesized to construe "the distance between the actual developmental level as determined by the independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978: 86). A stimulating learning environment and active social interaction with peers and educators within the learning context are vital for cognitive growth. Lev Vygotsky argues that "learning awakens a variety of developmental processes that are able to operate only when a child is interacting with people in his environment and in cooperation with his peers" (Vygotsky, 1997: 35). We perceive this concept as highly relevant to language learning, especially given the constructivist premise that working on tasks that challenge young learners' capabilities, and yet are made achievable by proper guidance, provides substantial learning benefits within the ZPD. It is argued that successful learning within the ZPD is triggered by involving the children in problem-solving, open-ended tasks – rather than traditional ones with routine procedures and predetermined solutions – and scaffolding the learning experience for them (Wood, Bruner and Ross, 1976). Following these principles, we invited the participants in our study to consider the cognitive benefits for young learners when designing language learning activities based on human- and AI-generated stories, so that they encourage collaboration and facilitate language progress within the ZPD.

Learning-centered, story-based language teaching

As far as language teaching approaches are concerned, we have chosen to design our study within the theoretical framework of using stories to encourage the development of language skills and active language production among young learners. In particular, we have followed the understanding of the holistic, learning-centered approach to language instruction (Cameron, 2001), which highlights the usage of stories as engaging educational resources for children as well as a basis for the design of targeted tasks and activities (Cameron, 2001; Arias, 2017). What we perceive as particularly valuable in Cameron's theoretical and practical perspective to early language learning are the clearly outlined aspects of making efficient use of stories in language classrooms. These aspects range from choosing tales which engage young learn-

ers and, more importantly, offer "space for language growth" (Cameron, 2001: 167) in terms of content, plot organization and use of language, to devising learning activities, based on stories, that support the development of different language skills. Additionally, we have chosen to adhere to the premises of the interactionist approach (Gass and Mackey, 2006, 2015) to language learning, where learners' output is actively promoted through interventions that provide meaningful input and feedback. Encouraging young learners to use the foreign language is viewed through the perspective of cognitive and social factors, affecting interaction (Gass and Mackey, 2006, 2015), so that the latter be conducive to language acquisition.

In the Companion Volume to the Common European Framework of Reference for Languages (2020), this focus on an active, action-oriented approach to language learning is even more pronounced and emphasized than in the original document of 2001 (although there, too, an entire chapter is devoted to the characteristics of language tasks and their role in language teaching). What is also worth noting is that the CEFR Companion Volume (2020) adds another level preceding the lowest level of language proficiency (pre-A1) to reflect the desire for an early start in foreign language learning and acknowledge what young learners can actually do with the language they have acquired. In this train of thought, we believe that even young children of preschool age with a limited vocabulary may successfully cope with the functional acquisition of the target language, capitalizing on the affordances of the Zone of Proximal Development (Vygotsky, 1978) under the support of skilled language instructors. Based on these tenets, the participants in our study were invited to design story-based action-oriented tasks and activities suitable for interactions with young learners in the foreign language classroom.

Use of generative AI in language instruction

As far as the usability of AI-generated textual output is concerned, our study stems from the well-grounded theoretical assertion that generative AI systems and tools, such as ChatGPT, are increasingly capable of producing coherent texts which are lexically and grammatically fluent (Chu and Liu, 2024; Godwin-Jones, 2024; Shah, 2023). Additionally, the linguistic aspects of AI-written output have been found to imitate closely those of human-created texts (Shah, 2023). We fully endorse the conclusions from recent research that highlight generative AI as complementary to human teaching capacity since "effective material development requires the consideration of the teaching context, student needs and interests, and course objectives - factors that AI alone cannot fully account for" (Öksüz Zerey, 2025: 153).

Within this theoretical framework, our study seeks to gain insight into the usability of AI-generated tales for the design of language-learning activities, as well as for enhancing young learners' language progress. Therefore, both a human-authored and an AI-generated story have been employed in the methodological task assigned to the study participants. In that light, we have tried to bridge the existing gap in literature and research which have so far primarily focused on human-authored stories in early foreign language education. We believe that AI-generated stories for children have certain potential and teachers can take advantage of the available AI tools to help them generate quality teaching materials.

Materials and Methods

This study took place in the months of November 2024 - January 2025. Students from several programmes in English studies and foreign language teaching offered at two major Bulgarian universities were invited to participate in it on a voluntary basis. The Moodle e-learning platform was used for data collection. The results from the subsequent analysis of teacher trainees' views on the use of human-written and AI-generated narratives in designing activities suitable for young learners' foreign language development are presented and discussed in this article.

To fulfil the objectives of our study, participants were tasked to carefully read two children's stories (one human-authored and one AI-generated) and assess some specific language learning and teaching implications related to them. The particular origin of the texts was not disclosed to the participants. Supplementary, they were further instructed to design language activities for preschool or primary school children based on the two narratives. The teaching goals for each of the suggested activities had to be outlined and justified.

The research questions participants needed to respond to in order to report on their perceptions of the usefulness and practical classroom application of the two stories were the following:

How useful is each story for developing young learners':

- foreign language comprehension? (Q1);
- foreign language production? (Q2);
- vocabulary in the new language? (Q3);
- grammar in the new language? (Q4);
- communicative skills? (Q5);
- narrative skills? (Q6);
- skills to elaborate their own fractured tale? (Q7).

How easily can each story be taught with reference to other fields of knowledge (i.e. interdisciplinary links)? (Q8).
How easily can each story be taught in an inclusive way, appropriate for intercultural classrooms? (Q9).
How can we use human-authored and AI-generated stories in early foreign language learning? (Q10).

For Q1-Q9, students could opt for 1 - "not at all", 2 - "slightly", 3 - "moderately" or 4 - "very" when assessing the usefulness of the two narratives on the first nine survey items.

The last item in this section of the survey (Q10) was intended as a methodology assignment which aimed at triggering students' creativity and raising their teaching competences. As has already been mentioned, they were encouraged to create educational content for classroom interactions with young learners.

Additional data on students' self-assessed skills and competences were collected. Teaching competences, manifested in their capacity to design educational content, language proficiency and abilities to use AI tools were measured on a 5-point Likert scale with possible responses ranging from 1 to 5 (1-minimal, 2-average, 3-good, 4-very good, 5-excellent). We decided on a self-reported measure as an alternative to external evaluation based on the premise that the participants' self-reflection and sense of personal knowledge, experience and qualifications are a reliable indicator and should be accounted for.

Two stories were selected to best address the objectives of the study. As mentioned above, the origin of the texts – human-authored or AI-generated – was not revealed to the students.

The rationale behind our choice of the human-authored story (referred to as Story A in the research questionnaire) had several aspects. First of all, we sought an authentic and fairly short text whose linguistic characteristics would match the comprehension level of primary school learners of English and, at the same time, enable them to expand their vocabulary and syntactical range (Gass and Mackey, 2015). Additionally, we aimed at selecting a story with a very clear narrative structure that would be consistent with what young learners have been accustomed to in their own experience with story engagement so far. The clarity and predictability of a story structure further facilitate comprehension (Hadaway and Young, 2010) while reinforcing awareness of how a narrative develops and how its elements are arranged. Thirdly, the selection of the human-authored text followed the premise that the usability of a story for educational purposes is related to its potential to engage learners both cognitively and affectively (Tomlinson, 2003). Thus, the human-written narrative for young learners was selected from among the variety of stories, offered as resources to English language teachers and parents in the LearnEnglish Kids section of the British Council's website https://learnenglishkids.britishcouncil.org.

The AI-generated story (referred to as Story B in the research questionnaire) resulted from an uninterrupted written interaction with ChatGPT-3.5, which occurred on 19 November 2024 from 19:20 hrs to 19:27 hrs. The prompts suggested to the generative AI model were devised in advance and referred to the following expected output characteristics: target audience, length of text, and key plot elements. No additional cues as regards the overall playful tone or action-driven orientation of the solicited content were suggested. The initial output from ChatGPT-3.5 was deemed satisfactory as it corresponded reasonably closely with the above linguistic, structural and engaging characteristics of the selected human-authored narrative. The perceived fluency and narrative consistency of the AI-generated output were congruent with findings from other studies (Shah, 2023; Godwin-Jones, 2024; Chu and Liu, 2024). Thus, we chose to submit no additional prompts to ChatGPT-3.5, seeking to adjust its initial written production.

A brief linguistic comparison between the human-authored and AI-written story provides additional insights. The human text is predominantly organized as a conversational interaction between the main characters, while the AI text follows a more descriptive, linear narrative development. Furthermore, the name of the pirate captain in the AI-generated story ('Blackbeard') conforms with the context very adequately and mirrors the captain's name in the human-authored text ('Redbeard'). Thus, ChatGPT displays the

capacity to match its linguistic output to specific contexts in a consistent, yet predictable and unoriginal way.

The scripts of the two narrative stories are presented herein below.

Story A

Sanjay saw a bottle floating in the sea. There was something inside it. He took it out.
'What is it?' asked Sarah.
'It's a map! It's a map!'
They looked round and saw a talking parrot.
'Buried treasure! Buried treasure!'
'Wow! A treasure map! Let's follow it.'
'Maybe it's gold!'
'Or silver?'
'Or jewels?'
'OK. We are here and the treasure is here.'
'Let's go! I'll read,' said the parrot. 'Walk 80 metres north.'
'1, 2, 3 … 78, 79, 80.'
'Turn right at the big coconut tree and go straight on until the crocodile pond. Cross the bridge, turn left and keep walking. Turn right in front of the big, round rock. Walk straight ahead for 50 metres.'
'1, 2, 3 … 48, 49, 50.'
'Go through the cave. Mind the bats! Mind the bats! Walk straight on until the beach. Go along the beach for 200 metres. The treasure is behind the square rock. Over there! Over there!', the parrot shouted.
'It's empty!' cried Sarah.
Inside there was an old note.
Dear Finder, Sorry, but I took my gold. I needed to buy a new pirate ship. Bye, Captain Redbeard.
'Well, at least we had a nice walk,' said Sanjay.
'Yes, and we made a new friend!'

Story B

One sunny afternoon, siblings Mia and Jake played in their backyard when Jake tripped over a rusty tin box buried under a tree. Inside, they found an old, crumpled map marked with a big red X. 'A treasure map!' Mia exclaimed.

The map led them to the forest nearby. As they puzzled over the directions, a squawking voice startled them. 'Treasure? Follow Polly!' A colourful parrot flapped down from a tree.

'You know where the treasure is?' Jake asked. The parrot bobbed its head. 'This way! This way!'

Polly led them through the winding forest paths, over a stream, and up a hill. Finally, they reached a small clearing where an ancient chest lay half-buried in leaves.

Excited, the children lifted the heavy lid, only to find the chest empty - except for a yellowed note. It read:

'To those who find this treasure, the real prize is the adventure you've had. Welcome to the crew! - Captain Blackbeard.'

Jake and Mia laughed.
'We didn't get gold,' Mia said, 'but we found Polly!'
Polly fluffed her feathers proudly. 'Best treasure ever!' she squawked.
And from that day on, the three friends were inseparable, ready for many more adventures.

Results and Discussion

We used the statistical package for social sciences IBM SPSS Version 23.0 for both descriptive and inferential statistics in the analysis of data. Mean and standard deviation of scores were computed to offer a picture of the set results as a whole, i.e. show the central tendency and the extent to which individuals in the group deviate from it. Further, paired sample t-test analysis was used to compare group differences of students' responses in relation to the extent to which they had assessed the usefulness of the two types of texts in early language education of children. Finally, Pearson correlation coefficient measure was employed to test if the registered differences in students' teaching competence, language proficiency and

use of AI levels would influence their valuation of the two types of texts.

Participants

Our selection of participants was a non-random convenience sample which is used in "most research in psychology" (McBurney and White, 2007: 248).

Two hundred and ten students (N=210) participated in the study. They represented the entire population of the students on the language teaching programmes at the universities. An overall high return rate of over 90.0 percent was recorded, which is indicative of participants' interest in the tasks proposed in the survey. The great majority of the students were females (N=196) and this did not come as a surprise for females have always predominated on teacher training university programmes. Students' mean age was 26.5 years. All participants had a good command of the English language and their proficiency level was above B1 (CEFR). What is worth noting is that among the participants, there were 18 international students from Austria, Spain, Greece, and Italy who were studying in Bulgaria on the Erasmus exchange or other programmes, as well as a couple of bilingual native speakers of English and Bulgarian.

Procedures

Usefulness of the two stories

First, to address research questions Q1-Q9, participants were asked to evaluate the extent to which they perceived the two stories useful for the development of different aspects of young learners' language skills and competences on a 4-point Likert scale. A summary of the results is offered in the table below.

Table 1. *Mean and standard deviation of participants' responses*

Usefulness of each story for the development of children's:	Narrative text	Mean	Std. Deviation
language comprehension (Q1)	Story A	3.19	0.741
	Story B (AI text)	3.23	0.771
language production (Q2)	Story A	3.15	0.710
	Story B (AI text)	3.20	0.785
vocabulary (Q3)	Story A	3.25	0.731
	Story B (AI text)	3.49	0.672
grammar (Q4)	Story A	2.88	0.772
	Story B (AI text)	3.37	0.715
communicative skills (Q5)	Story A	3.21	0.770
	Story B (AI text)	3.07	0.785
narrative skills (Q6)	Story A	2.94	0.819
	Story B (AI text)	3.37	0.792
skills to elaborate their own fractured tale (Q7)	Story A	3.01	0.874
	Story B (AI text)	3.40	0.757
interdisciplinary skills (Q8)	Story A	3.11	0.826
	Story B (AI text)	3.05	0.871
intercultural skills (Q9)	Story A	3.17	0.771
	Story B (AI text)	3.12	0.845

As is seen, the usefulness of text B in most designated aspects of language education was perceived by trainee teachers as more robust compared to that of text A. We used paired sample t-test to further check the strength of the registered group differences. Analysis revealed four areas in which the AI-generated story strongly outperformed the human-authored one, with the corresponding differences being statistically significant (i.e. for "developing vocabulary in the new language": t= -3.425; df= 209; p = 0.001; for "developing grammar in the new language": t= -6.641; df= 208; p = 0.000; for "developing young learners' narrative skills": t= -5.287; df= 202; p = 0.000; and for "fostering young learners' skills to develop their own fractured tale": t= -4.999; df= 204; p = 0.000). Graphical representation of the results follows:

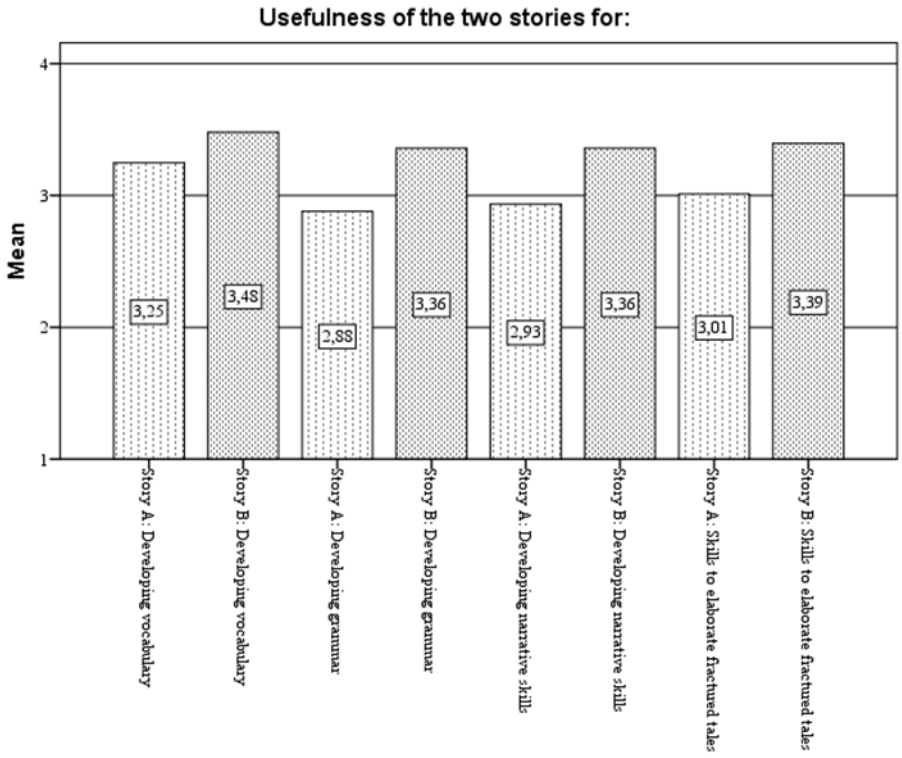

Figure 1. *Statistically significant differences in students' perceptions regarding the usefulness of the two stories for the development of different aspects of young learners' language skills and competences.*

The above aspects of perceived language-learning usability of story B can be viewed in the light of the increasing fluency of AI-generated output (Shah, 2023; Godwin-Jones, 2024). Our own experience with written and oral exchanges with ChatGPT confirms the capacity of this large language model to mimic human linguistic production fairly convincingly.

These findings of our study indicate clearly that the AI-authored story is regarded by novice teachers as an educational material which can positively impact the development of young learners' lexical, grammatical, narrative and narrative-transformative skills. The results strongly suggest that AI textual output, which has been carefully curated to meet specific language learning goals, can successfully complement teaching materials. Previous research on incorporating human-authored tales in language learning yields similar benefits for children's linguistic output (Isbel et al., 2004; Gass and Mackey, 2015; Nicolopoulou, 2017; see also Brinton and Fujiki, 2017; Fojkar et al., 2013; Wen, 2021).

Proposed language activities

To address our research question 10 (Q10), we next invited students to create foreign language content for young learners based on the two stories.

Among the proposed students' methodological designs which aimed to foster children's comprehension, production and communicative skills in English were different treasure hunt simulations, various roleplays and acting out activities, teamwork suggestions, etc. Changing the script/plot of the story, inventing short dialogues between different characters, transforming the tale to add a new adventure or story character were brought up as useful tools and techniques for developing young learners' narrative skills and skills to elaborate their own fractured tale. Sample activities of using stories for developing children's vocabulary and grammar in the new language were somewhat more traditional. They encompassed introducing and reinforcing specific vocabulary, e.g. directions (north, south, east, west), measurements (meters), the natural world (sea, bottle, coconut tree, crocodile pond, forest, stream, hill), emotions (excited, disappointed), etc. Interdisciplinary skills were also involved in view of specific vocabulary. Grammar included categories like past tense verb forms, prepositions, etc. Crosswords, quiz games, bingos, etc. were among the suggested fun language activities. Finally, activities encouraging inclusion of all children and enhancing their comprehension and production ranged from joint visual representations of the sto-

ries, counting aloud, following commands, singing and dancing together. On the whole, participants in the study displayed a fairly high degree of understanding of language learning as a collaborative experience.

In summary, there has been a wide array of students' proposals for various ways of incorporating each story in creative language learning activities for children. We could not possibly account for all instances and exhaust the matter in depth for these methodological designs need to be systemized and categorized in a structured way which is beyond the scope of the present paper. Yet, it will be fair to conclude that teacher trainees have displayed a great deal of enthusiasm, engagement and creativity in their ventures, trying to bridge different theories and practices in their classroom interaction with children. The study participants viewed both texts as appropriate and useful in the foreign language education of children, despite the perceived overall advantages of the ChatGPT-generated story for language teaching purposes. They appreciated different features in both stories: the appeal for young learners of the two action-oriented plots, rich in humorous twists and reflective messages on friendship and adventure. The latter are highlighted in most teacher trainees' responses and subsequently reflected in their proposed creative methodological designs.

To illustrate participants' performance in the assigned task, we offer below samples of two designs of language learning activities, one by a bilingual foreign student and one by a Bulgarian student. As is seen in the examples, both the human and AI stories can be successfully used as the basis for a treasure hunt-themed activity, aimed at learners of different ages.

Two case studies of students' proposals for language learning activities for children

Task prompt: Suggest a way of incorporating each story into the design of a language learning activity for primary school children. When designing the activities, have in mind particular teaching goals. Outline each activity in the appropriate space below. Indicate learners' age for each activity.

Design 1 (by participant No 73)

STORY A	**STORY** B
Activity: Picture sequencing &retelling	***Activity:*** Treasure hunt & new vocabulary
Age Group: 6-8 years old	***Age Group:*** 7-9 years old
Goal: Improve listening and speaking skills	***Goal:*** Learn new vocabulary and practise giving directions
How it works: The teacher provides pictures representing key moments from the story. Children listen to the story, then work in groups to arrange the pictures in the correct order. Afterward, they retell the story using simple sentences, practising vocabulary and sentence structure.	***How it works***: After reading the story, children are given a "treasure map" with clues written in English. Each clue contains a simple instruction ("Go two steps forward and look under the chair"). They must follow the directions to find small "treasures" (stickers, flashcards, or small toys). This activity helps reinforce prepositions of place, action words, and storytelling elements.
Teaching goals: Help kids understand spoken English by listening to the story; Teach them how to put events in order so they follow the story correctly; Let them practise speaking by retelling the story in their own words; Introduce new words related to the story to enrich their vocabulary.	***Teaching goals***: Make learning fun by using a treasure hunt to teach directions; Teach words like "under", "next to" and "behind" through movement and actions; Encourage teamwork by having students work together to find clues; Improve thinking skills by using simple puzzles or step-by-step instructions.

Design 2 (by participant No 114)	
STORY A	**STORY B**
***Activity*:** Treasure hunt simulation	***Activity*:** Parrot story creator
***Age*:** 6-7 years old	***Age*:** 8-10 years old
***Steps*:** Create a large map in the classroom or playground resembling the one in the story. Include landmarks like a coconut tree, crocodile pond, and cave. Read the story aloud, pausing at the directional commands. Ask learners to follow these directions on the map to find a hidden "treasure chest". Once they reach the "treasure", have a group discussion about what they found and practise new vocabulary (e.g. north, straight, left, right).	***Steps*:** Discuss the parrot's role in the story and its humorous comments. Have learners work in pairs to invent a short dialogue between the parrot and the children, imagining a new adventure. Each pair presents their dialogue to the class, focusing on using expressive language and incorporating humor.
***Teaching goals*:** Develop comprehension of directional language; Practise action verbs (walk, turn, cross); Encourage teamwork and active participation.	***Teaching goals*:** Develop conversational skills and creativity; Practise forming sentences and using vocabulary in a playful context; Build confidence in speaking and presenting.

The above samples are indicative of the comparable potential of both AI-generated and human-written stories to serve as a pedagogically appropriate basis for the design of language learning activities. Secondly, participants in our study adopted an increasingly multidimensional and age-appropriate approach to activity design to promote language use via the active involvement of young learners. The suggested methodological designs are strongly aligned with the understanding that empowering learner agency in young children (Isbel et al., 2004) is at the core of material selection for language classrooms and activity design to support language progress (Larsen-Freeman et al., 2021). Furthermore, the samples of novice teachers' designs of language learning activities exemplify the current views of early language teaching as a set of communicative, playful and enjoyable practices that aim higher than the acquisition of mere functional literacy (Harizanova, 2020; Bland, 2022). Sparking the curiosity and the sense of delight in young learners can be best achieved through narratives whose cognitive and emotional complexity prevails over the linguistic one (Tomlinson, 2003). Additionally, the suggested activity designs highlight the benefits of engaging young learners in joint pursuits that incorporate sensory and physical stimuli along with collaborative communication, thus adding to the affective and social meaningfulness of language instruction. This methodological aspect of the study findings echoes views of group learning as promoting general learning strategies (Cole et al., 2017) and making language progress durable, as well as emotionally satisfactory (Bland, 2022; Nilsson, 2025).

Students' teaching competence and skills

Finally, our last study objective was to seek for meaningful relations between students' self-reported teaching competence, language proficiency, and skills to use AI tools on the one hand, and on the other hand, their perceptions of the usefulness of the two stories for enhancing second language use in young children. Means and standard deviation scores were computed for the studied variables. Results showed that students had assessed their competences and skills moderately high (for teaching competence: mean 3.15, std. dev. 0.96; for language proficiency: mean 3.70, std. dev. 0.81; and for skills to use AI tools: mean 2.84, std. dev. 1.05). All means were above or close to the midpoint of 3.00, and it was quite expected that the language proficiency and teaching competence of teacher trainees would outweigh their AI usage skills.

Pearson correlation coefficient revealed meaningful relationships between students' teaching competence and their perceived usefulness of story A (the human-authored narrative) for developing young learners' grammar ($r = 0.146^*$; $p = 0.04$) and building up communicative skills ($r = 0.172^*$; $p = 0.01$) in the new language. Such correlations were not found significant in relation to the AI-generated narrative.

Students' competence also correlated positively with their assessment of the degree of ease to teach both stories with reference to other fields of knowledge (for story A: r =0.172*; p = 0.01); (for story B: r =0.177*; p = 0.01). The higher the experience of the students in designing language learning activities, the stronger their awareness of various interdisciplinary links to other fields of knowledge (e.g. maths, geography, the natural world, etc.) they could make using both texts in their classroom interaction. This finding holds promise for language classrooms in Bulgaria as the capacity to interweave cross-curriculum references in language teaching brings added value to the learning process. Designing language-learning tasks to empower not only confident language command but also to support the development of skills and knowledge in extra-linguistic areas has been proven a beneficial practice (Arnold and Rixon, 2011; Daniel, 2012; Richards and Rogers, 2014).

On the other hand, students' language proficiency was not correlated to any of the studied constructs which means that students' evaluation of the usefulness of the two texts in foreign language teaching does not depend on how proficient they are in that foreign language. It should be noted, though, that teacher trainees' proficiency in English was above level B1, which is one of the state requirements for obtaining the foreign language teacher qualification. In this sense, the study participants' views can be regarded as reasonably objective.

Finally, students' skills to use AI tools correlated positively with their perceptions of the usefulness of story A for developing young learners' vocabulary (r =0.146*; p = 0.04) and communicative skills (r =0.153*; p = 0.03). Once again, interestingly, these correlations were statistically significant only in relation to the human-authored text. The tentative interpretation of this finding we can offer is that the more skilled interactions with AI tools – in particular, large language models, such as ChatGPT – attune the users to the stylistic constraints of their fluent, yet often unoriginal, output.

Conclusions

The study confirmed the usability and the potential of both AI-generated and human-authored narrative texts as complementary resources for early language learning. In particular, the applicability of AI-written stories for the development of meaningful and interactive language learning activities has been convincingly highlighted in the results from this survey conducted among trainee teachers of English. Furthermore, AI-generated and human-authored narrative texts were perceived as comparably conducive to the promotion of both linguistic and general cognitive and social skills in young language learners. These findings corroborate the specific theoretical framework of language learning and usability of AI systems in language education, underpinning our research. Furthermore, to the best of our knowledge, these methodological perspectives have not been previously addressed in research and broaden the existing approaches to using AI-generated output in early language instruction.

An additional finding that merits highlighting with a view to research on early language learning is the established positive correlation between novice language teachers' experience in activity design for language learning purposes and their ability to relate young learners' linguistic skills to other, extralinguistic areas of knowledge. This resonates with the strive for holistic, learner-centred pedagogies in language education.

Limitations of the present study, both theoretical and practical, need to be properly acknowledged. Firstly, the survey was conducted among novice language teachers. Secondly, the language of the sources that we have referred to is predominantly English, which reduces the scope of available research that may be relevant to the chosen topic. Furthermore, our study collected and analyzed self-reported data which calls for caution as to the generalizability of the findings.

We believe that further exploration of how AI output or AI tools can be meaningfully used in language instruction merits continued highlighting. Further to that, identifying ethical guidelines for the responsible employment of AI systems in educational practices will be of significant value.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Institutional Review Board Statement

The study was conducted in full compliance with the principles of the Declaration of Helsinki. Institutional Review Board approval was not required since the study did not approach human participants in any interventional way and no vulnerable subjects or groups were involved. All participants were adult university students who took part in the survey on a voluntary basis. Informed consent was obtained prior to data collection. Minimal risk for research respondents was ensured. Fully anonymized datasets were used which do not allow participants to be traced.

Author Contributions

Conceptualisation, E.N.S., S.G.D.-G. and C.N.B.; methodology, E.N.S., S.G.D.-G. and C.N.B., software, E.N.S., formal analysis, E.N.S., S.G.D.-G. and C.N.B., writing—original draft preparation, E.N.S., S.G. D.-G. and C.N.B., writing—review and editing, E.N.S., S.G.D.-G. and C.N.B.; funding acquisition, E.N.S.; supervision, E.N.S. All authors have read and agreed to the published version of the manuscriptf.

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Digital Dependency and Sleep Deprivation: The Dual Roles of Addiction and Burnout in Modern Media Consumption

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Abstract: Excessive reliance on digital media has raised global concerns about its implications for sleep health, yet limited research has examined how addiction and burnout jointly shape this relationship. Addressing this gap, the current study aims to investigate the dual roles of social media addiction and burnout in the link between digital dependency and sleep deprivation. A quantitative design was employed, drawing on survey data from 557 university students exposed to high levels of social media usage. A moderated mediation model was analyzed to test the direct effect of digital dependency on sleep disorder, the mediating effect of addiction, and the moderating influence of burnout. Results revealed three pivotal findings: first, digital dependency significantly predicts sleep disturbances; second, social media addiction fully mediates the dependency–sleep relationship, indicating that heightened reliance transforms into disordered sleep primarily via addictive patterns; and third, burnout amplifies the impact of dependency on sleep disorder, both directly and through addiction, thus exacerbating negative outcomes for those already experiencing emotional exhaustion. These insights underscore the intricate interplay between psychological states and behavioral tendencies, highlighting that mere dependency does not inevitably trigger poor sleep unless addictive and burnout processes emerge. By clarifying these pathways, this research contributes nuanced evidence to inform policy and practice, emphasizing the need for interventions that curtail compulsive media engagement and manage burnout symptoms. Ultimately, the findings advocate for balanced, self-regulated digital usage to safeguard physical and mental well-being in an increasingly digitized society.

Keywords: Social Media Addiction, Sleep Disorders, Digital Dependency, Social Media Burnout.

Introduction

The advent of social media platforms has markedly transformed communication modalities, particularly among adolescents and young adults, engendering considerable apprehension regarding its ramifications on mental and physical health (Ajewole, 2024; Tiwari, 2023). Contemporary research posits that whilst social media enables social interaction and support, it concomitantly engenders risks that may adversely affect mental well-being, culminating in issues such as anxiety and depression (Anguyo et al., 2023; Schønning et al., 2020; House, 2023). For example, an escalation in time allocated to social media correlates with heightened levels of anxiety and depression among adolescents, exacerbated by upward social comparisons with idealized online personas (Pratoom, 2021; Titisuk et al., 2023; Plackett et al., 2023). This phenomenon is further intensified by environments conducive to cyberbullying and unrealistic standards of beauty and success, which significantly undermine self-esteem and contribute to psychological distress (Yuliyanti et al., 2021; Di-Pomponio and Cerniglia, 2024; Tiwari, 2023). Furthermore, excessive utilization of social media has been associated with sedentary behavior, leading to deleterious health outcomes such as obesity and diminished sleep quality (Shimoga et al., 2019; Anguyo et al., 2023). Notably, a U-shaped relationship exists between social media use and physical activity, whereby moderate use is linked to more favorable health outcomes compared to both excessive and minimal use, thus highlighting the "Goldilocks effect" (Moorhead et al., 2013; Pratoom, 2021). Sleep disorders, emerging as a significant public health concern, have profound implications for overall well-being, especially among individuals with elevated social media engagement (Chen et al., 2024; Ye et al., 2024; Zhang et al., 2023).

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The emotional and cognitive arousal associated with social media use, particularly prior to bedtime, contributes to sleep disturbances, including insomnia and reduced sleep quality (Krishnan and Chew, 2024; Li et al., 2024; Chen et al., 2024). This underscores the intricate interplay between social media use and sleep health, necessitating further scholarly exploration (Ye et al., 2024; Krishnan and Chew, 2024).

Comprehending the dual roles of addiction and burnout in contemporary media consumption is imperative, given their substantial impact on mental and physical health (Li et al., 2024; Horozoğlu and Gündüz, 2024). Burnout, characterized by emotional exhaustion and diminished motivation, has been linked to excessive social media use, exacerbating feelings of fatigue and cynicism (Şahin and Akçay Bekiroğlu, 2023; Krishnan and Chew, 2024). The interplay between social media addiction and burnout presents a complex dynamic wherein each exacerbates the other, leading to a detrimental cycle affecting individuals' well-being (Li et al., 2024; Liu and Ma, 2020; Krishnan and Chew, 2024). Additionally, the bidirectional relationship between sleep disturbances and mental health conditions, such as depression and anxiety, further complicates this issue (House, 2023; Plackett et al., 2023; Tiwari, 2023). For instance, poor sleep quality mediates the relationship between social media use and mental health outcomes, indicating that sleep disturbances can both result from and contribute to mental health disorders (Chen et al., 2024; Ye et al., 2024; Krishnan and Chew, 2024). In light of these challenges, the present study aims to investigate the dual roles of addiction and burnout in modern media consumption, particularly focusing on their impact on digital dependency and sleep deprivation (Li et al., 2024; Liu and Ma, 2020; Horozoğlu and Gündüz, 2024). By exploring these dynamics, the research endeavors to contribute to a deeper understanding of how excessive social media use influences mental and physical health, and to inform interventions that promote healthier online behaviors (Moorhead et al., 2013; Brennan and House, 2023; Şahin and Akçay Bekiroğlu, 2023). Considering individual differences, such as emotional intelligence and self-regulation, is essential in developing strategies to mitigate the adverse effects of social media addiction and burnout (Şahin and Akçay Bekiroğlu, 2023; Anguyo et al., 2023). Ultimately, fostering a balanced approach to social media engagement may alleviate sleep disturbances and enhance overall well-being (Krishnan and Chew, 2024; Ye et al., 2024; Chen et al., 2024).

Notwithstanding extensive scholarship on the deleterious consequences of excessive social media utilization on mental and physical health, a notable gap persists in fully apprehending the complex interrelations among social media dependence, addiction, burnout, and sleep disorders (Li et al., 2024; Liu and Ma, 2020; Krishnan and Chew, 2024). Prior research has predominantly concentrated on the direct associations between social media use and negative health outcomes, yet has inadequately illuminated the mediating and moderating mechanisms underpinning these relationships (Chen et al., 2024;Ye et al., 2024). Accordingly, this study endeavors to address this lacuna by exploring how social media addiction mediates the relationship between social media dependence and sleep disorder, and how social media burnout moderates this association. By scrutinizing these dynamics, the research aspires to contribute valuable insights into the dual roles of addiction and burnout in contemporary media consumption, thereby augmenting our comprehension of their impact on digital dependency and sleep deprivation ((Li et al., 2024; Horozoğlu and Gündüz, 2024). The objectives are threefold: firstly, to ascertain the mediating effect of social media addiction on the relationship between social media dependence and sleep disorder; secondly, to evaluate the moderating influence of social media burnout on this direct relationship; and thirdly, to examine how the indirect effect of social media dependence on sleep disorder via addiction varies across differing levels of burnout. Ultimately, this research seeks to inform the development of targeted interventions aimed at ameliorating the adverse health repercussions associated with excessive social media use, thereby promoting healthier online behaviors and enhancing overall well-being (Moorhead et al., 2013;Şahin and Akçay Bekiroğlu, 2023). Based on the above-mentioned research objectives, the research questions are formulated as below:

1. What is the direct relationship between social media dependence and sleep disorder?
2. What extent does social media addiction mediate the relationship between social media dependence and sleep disorder?
3. How does social media burnout moderate the direct relationship between social media dependence and sleep disorder?
4. How does the indirect effect of social media dependence on sleep disorder through social media addiction vary at different levels of social media burnout?

A growing body of empirical research indicates that social media dependence has a significant positive direct effect on sleep disorders. Numerous studies have shown that excessive social media use is correlated with poorer sleep quality and heightened psychological distress (Azizi et al., 2019; Sumen and Evgin, 2021). For instance, both high school and college students have experienced reduced sleep quality due to social media addiction (Azizi et al., 2019; Wijaya and Widiantoro, 2020). Additionally, Sumen and Evgin (2021) found that social media addiction is linked to psychological problems and sleep disorders among adolescents. Healthcare professionals who engage in nighttime social media use report increased sleep disturbances and anxiety (Rajeh et al., 2022; Levenson et al., 2016). Levenson et al. (2016) also suggested that individuals might use social media as a distraction, inadvertently worsening sleep issues. Moreover, addictive social media use disrupts sleep patterns, resulting in insomnia and delayed bedtimes (Lin et al., 2021; Shabahang et al., 2024). Lin et al. (2021) observed longitudinal relationships between addictive social media use and insomnia in adolescents. The negative effects extend to academic performance, as sleep disturbances impair concentration and learning abilities (Kolhar et al., 2021; Zhu et al., 2023). Kolhar et al. (2021) emphasized that sleep disturbances from excessive social media use adversely affect academic performance and focus. Emotional investment in social media may lead to anxiety, complicating the onset of sleep (Buda et al., 2020; Woods and Scott, 2016). Furthermore, Wijaya and Widiantoro (2020) observed that excessive use of platforms like Twitter and WhatsApp affects sleep quality among nursing students. Woods and Scott (2016) identified a relationship between nighttime social media use and increased anxiety and depression, resulting in poor sleep quality. Thus, understanding the direct impact of social media dependence on sleep disorders is crucial for developing effective interventions. Therefore, this study proposes hypothesis 1: (H1): Social media dependence has a significant positive direct effect on sleep disorder.

Additionally, a myriad of psychological and social factors contribute to this dependence, intensifying addictive behaviors (Bilgin and Taş, 2018; Hou et al., 2019). Adolescents subjected to heightened stress and societal pressures are particularly susceptible to social media addiction (Khatimah and Ryan, 2023; Pawlikowska et al., 2022). Elements such as cyberbullying and online self-comparison exacerbate addiction rates among vulnerable youth (Khatimah and Ryan, 2023; Rustamov et al., 2023). A diminution in self-esteem correlates with increased levels of social media addiction, indicating that individuals may resort to social media as a compensatory mechanism (Pawar and Shah, 2019; Mousa, 2023). Moreover, a decline in tangible social support compels individuals to seek online connections, thereby fostering addictive tendencies (Bilgin and Taş, 2018; Pawlikowska et al., 2022). Aggression mediates this association, as addiction is linked to heightened aggression, adversely affecting well-being (Rustamov et al., 2023; Hou et al., 2019). Consequently, interventions that address underlying psychological factors are imperative (Mousa, 2023; Pawar and Shah, 2019). Collectively, the evidence substantiates the hypothesis that social media dependence significantly contributes to social media addiction while social media dependence is recognized as a significant positive predictor of social media addiction among adolescents and young adults; thereby underpinning hypothesis 2a of the current study is formulated as: (H2a): Social Media Dependence has a significant positive effect on Social Media Addiction.

Furthermore, emerging evidence suggests that social media dependence markedly contributes to the progression of social media addiction, with individuals increasingly engaging compulsively with online platforms (Sumen and Evgin, 2021; Evers et al., 2020). This dependence not only precipitates addiction but also exerts a deleterious impact on sleep quality (Külekçioğlu and Çetin, 2021; Woods and Scott, 2016). Moreover, exposure to blue light from electronic devices disrupts melatonin production, thereby exacerbating sleep problems (Rasheed and Saba, 2023; Rajeh et al., 2022). The ramifications extend to psychological well-being and academic performance, underscoring the broader implications of social media addiction (Evers et al., 2020; Woods and Scott, 2016). It is therefore imperative to address social media dependence to ameliorate sleep health and reduce psychological distress (Rasheed and Saba, 2023; Abdalqader et al., 2018). This necessity is further highlighted by studies advocating for interventions targeting addictive behaviors (Sumen and Evgin, 2021; Külekçioğlu and Çetin, 2021). Accordingly, this study posits hypothesis 2b as follows while empirical findings corroborate this hypothesis, demonstrating a strong correlation between excessive social media use and sleep disturbances, including insomnia (Rajeh et al., 2022; Abdalqader et al., 2018). (H2b) Social media addiction has a significant positive effect on sleep disorders

Moreover, an extensive corpus of research indicates that social media addiction substantially mediates the relationship between social media dependence and sleep disorders (Luo and Hu, 2022; Dhir et

al., 2021; Rasheed and Saba, 2023). This mediatory effect is evident through the adverse impact of excessive social media usage on sleep quality and duration, culminating in psychological distress and negative physical health outcomes (Woods and Scott, 2016; Evers et al., 2020; Abdalqader and Joseph, 2020). For example, studies have shown that high school students with elevated levels of social media addiction report diminished sleep quality and increased psychological issues (Sümen and Evgin, 2021; Evers et al., 2020). Likewise, research among university students has demonstrated an inverse correlation between social media addiction and sleep quality (Hjetland et al., 2021; Luo and Hu, 2022). Healthcare professionals have experienced heightened sleep disturbances attributable to extended nocturnal social media engagement, which disrupts sleep through intensified emotional arousal (Rajeh et al., 2022; Rasheed and Saba, 2023). Furthermore, patients with fibromyalgia have reported greater sleep disturbances linked to higher levels of social media addiction, suggesting detrimental implications for both psychological and physical health (Külekçioğlu and Çetin, 2021; Dhir et al., 2021). Additionally, excessive social media engagement serves as a maladaptive coping mechanism among adolescents, exacerbating sleep issues in the context of academic stress (Evers et al., 2020; Woods and Scott, 2016). Further studies corroborate that excessive social media use is directly associated with poorer sleep outcomes among young adults (Abdalqader and Joseph, 2020; Hjetland et al., 2021). This pattern is similarly evident in high school students, where social media addiction correlates with reduced sleep quality and psychological distress (Sümen and Evgin, 2021; Rajeh et al., 2022). Conjointly, these findings (Luo and Hu, 2022; Dhir et al., 2021; Külekçioğlu and Çetin, 2021) lend robust support to the proposed hypothesis 2c of the current study, affirming that (H2c) Social media addiction significantly mediates the relationship between social media dependence and sleep disorders. Then, hypothesis 3, put forward in the present study, contends that (H3) Social Media Burnout significantly moderates the direct relationship between Social Media Dependence and Sleep Disorder, such that the association is intensified when burnout levels are elevated.

This proposition is corroborated by studies suggesting that burnout exacerbates the detrimental effects of social media dependence on sleep quality (Jiang, 2021; Woods and Scott, 2016). For instance, individuals exhibiting high levels of burnout are more prone to problematic social media utilization and subsequent sleep disturbances (Jiang, 2021; Evers et al., 2020). Emotional exhaustion, a principal element of burnout, markedly impairs sleep quality (Sánchez-Narváez et al., 2023; Membrive-Jiménez et al., 2022). Moreover, Evers et al. (2020) demonstrated that academic burnout directly influences sleep disturbances within the context of social media usage. Likewise, Woods and Scott (2016) observed that increased emotional investment in social media correlates with poor sleep quality and heightened anxiety. Additionally, Sánchez-Narváez et al. (2023) emphasized that emotional fatigue arising from excessive social media engagement leads to a pernicious cycle of diminished sleep quality and burnout. All in all, these findings underscore the assertion that elevated levels of social media burnout amplify the adverse effects of social media dependence on sleep disorders.

As a final point, prior studies have demonstrated a significant correlation between social media addiction and diminished sleep quality (Hussain and Griffiths, 2019; Masoed et al., 2021; Sümen and Evgin, 2021). Specifically, dependence on social media engenders compulsive usage patterns that disrupt circadian rhythms, culminating in sleep deprivation (Lin et al., 2019; Hussain and Griffiths, 2019). Social media burnout exacerbates these adverse outcomes, as emotional exhaustion from excessive use amplifies the impact of addiction on sleep disturbances (Charoensukmongkol, 2016; Salvagioni et al., 2017). Moreover, burnout can precipitate psychological distress and occupational repercussions, further affecting sleep (Salvagioni et al., 2017; Yamini and Pujar, 2022). Elevated levels of burnout are associated with increased sleep disruptions (Zarei and Fooladvand, 2022; Sümen and Evgin, 2021). Consequently, addressing social media burnout is imperative for mitigating the detrimental effects of social media addiction on sleep disorders (Yamini and Pujar, 2022; Charoensukmongkol, 2016). This underscores the necessity for interventions targeting burnout to enhance sleep quality among frequent social media users (Lin et al., 2019;Masoed et al., 2021). Taken altogether, the hypothesis 4 of the present research asserts that (H4): The indirect effect of social media dependence on sleep disorders via social media addiction is contingent upon the level of social media burnout, with the mediation effect becoming more pronounced at elevated burnout levels.

Materials and Methods

The current investigation adopts a quantitative research methodology, utilizing a questionnaire survey to explore the complex dynamics among social media dependence, addiction, burnout, and sleep disorders. In particular, the study implements a conditional process analysis, employing a moderated-mediation model, indicated in Figure 1 below, as articulated by (Karazsia et al., 2013). This framework integrates mediating and moderating variables to elucidate the associations between social media dependence (X) and sleep disorder (Y). The mediating construct, social media addiction, is theorized to transmit the effects of dependence on sleep disturbances, as underscored by Liu (2023). Furthermore, the moderating effect of social media burnout is assessed to investigate its impact on both the direct pathway (Path c') and the conditional indirect effect (H3, H4) of dependence on sleep disturbances, reflecting the theoretical principles outlined by Bachl (2017). This research contributes to a refined understanding of digital dependency and its repercussions for sleep health, drawing upon the methodological insights of Crowson (2024) and Bhattacharya (2023).

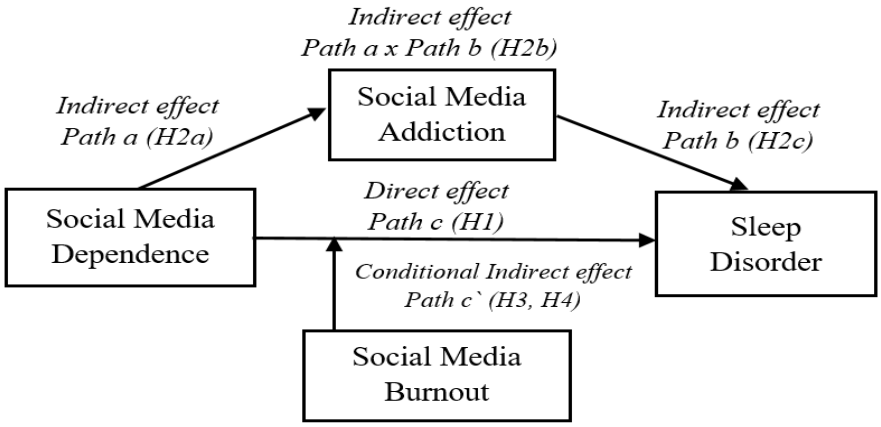

Figure 1. Framework: Conditional Process Analysis Model (Moderated-Mediation Model)

Figure 2 presents the demographic characteristics of the study participants. The gender split was approximately even, with males representing 49.01% (n=273) and females 50.99% (n=284). Participants were enrolled across four colleges: College of Journalism and Communication (20.11%, n=112), College of Film and Cinema or School of Cinematic Arts (24.78%, n=138), College of Communication Technology (25.67%, n=143), and College of Broadcasting and Hosting Arts or School of Broadcasting and Presentation Arts (29.44%, n=164). Regarding daily social media usage, 16.7% (n=93) used social media for over 3 but less than 5 hours, 46.3% (n=258) for over 5 but less than 7 hours, and 37.0% (n=206) for more than 7 hours.

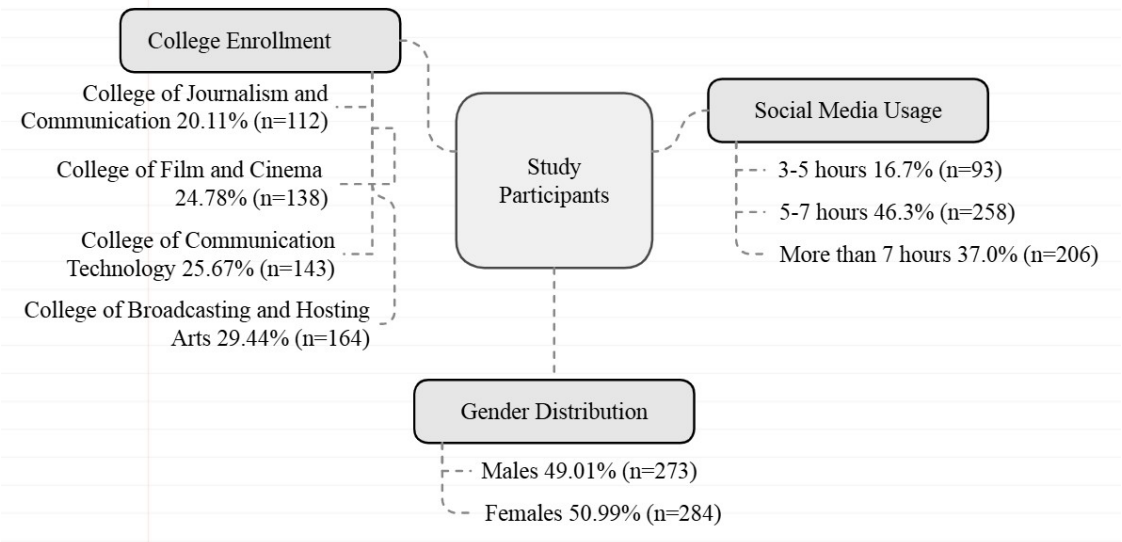
College Enrollment
College of Journalism and Communication 20.11% (n=112)
College of Film and Cinema 24.78% (n=138)
College of Communication Technology 25.67% (n=143)
College of Broadcasting and Hosting Arts 29.44% (n=164)
Study Participants
Social Media Usage
3-5 hours 16.7% (n=93)
5-7 hours 46.3% (n=258)
More than 7 hours 37.0% (n=206)
Gender Distribution
Males 49.01% (n=273)
Females 50.99% (n=284)

Figure 2. Demographic Characteristics of Participants (n=557)

Research Instruments

The research utilizes four rigorously validated assessment tools that demonstrate strong psychometric properties as indicated in Table 1 below. Initially, the Social Media Disorder Scale (Boer et al., 2021) represents a streamlined nine-item measure based on DSM-V criteria, showing good reliability (α=0.76) and stability (ICC=0.663). Factor analysis confirms its structural integrity (CFI=0.997, RMSEA=0.041), supporting its use in empirical research. Secondly, the S-MASS (Chanpen et al., 2023) implements a three-factor model capturing key aspects of social media addiction: prioritization, negative outcomes, and control deficits. Statistical analyses demonstrate strong internal consistency (α=0.90) and factorial validity through both EFA and CFA procedures (CFI=0.99, RMSEA=0.01). Then, the SRSQS (Chen et al., 2021) evaluates sleep quality across six domains using 28 items. The measure shows excellent reliability (α=0.92, test-retest=0.81) and correlates significantly with established sleep measures, indicating strong criterion validity. Its ability to distinguish between clinical and non-clinical groups further supports its utility. Lastly, the Social Media Burnout Scale (Wang et al., 2024) measures burnout through emotional exhaustion and depersonalization dimensions. Statistical analyses support its reliability (α=0.92) and construct validity (AVE>0.50, CR>0.70). The measure's factor structure aligns with theoretical conceptualizations of social media burnout, making it particularly relevant for contemporary digital health research.

Table 1. *Summary of Four Research Instruments*

Instrument title	Authors	Dimensions & items	Likert Scale	Reliability & Validity
Social Media Disorder Scale (SMDS)	Boer et al. (2021)	1 Dimension (Social Media Addiction); 9 items	5-point (1–5)	α=0.76 Good fit indices (CFI=0.997, RMSEA=0.041)
Social-Media Addiction Screening Scale (S-MASS)	Chanpen et al. (2023)	3 Dimensions (Priority, Neg. Conseq., Imp. Control); 16 items	5-point (1–5)	α 0.90 (overall) EFA & CFA support 3-factor structure
Self-Report Sleep Quality Scale (SRSQS)	Chen et al. (2021)	6 Domains (Daytime Symptoms, Sleep Satisfaction); 28 items	5-point (1–5)	α=0.92, test-retest= 0.81 Strong correlation with PSQI, discriminates insomnia vs. control
Social Media Burnout Scale (SMBS)	Wang et al. (2024)	2 Dimensions (Emotional Exhaustion, Depersonalization); 30 items	5-point (1–5)	α = 0.92 (overall), EE=0.94, DP=0.82 Good AVE (>0.5), CR (>0.7), discriminant validity

Procedure, Data Collection, and Analysis

Between April and July 2024, data were collected via an electronic questionnaire disseminated online to students enrolled at Wuhan University of Communication in Jiangxia District, Wuhan, China. Participants were drawn from the College of Journalism and Communication, the College of Film and Cinema (School of Cinematic Arts), the College of Communication Technology, and the College of Broadcasting and Hosting Arts (School of Broadcasting and Presentation Arts). Ultimately, 568 responses were secured, with 557 deemed valid and 11 excluded owing to incomplete information. For data analysis, the PROCESS macro within SPSS was employed to perform a moderated mediation analysis, identifying Sleep Disorder as the outcome variable (Y), Social Media Dependence as the predictor (X), Social Media Addiction as the mediator (M), and Social Media Burnout as the moderator (W). The quantitative findings encompassed direct (c path), indirect (a × b), and total (c + ab) effects, alongside moderation indices, R^2 values, confidence intervals, and significance levels (Crowson, 2024; Hinton et al., 2023). Both standardized and unstandardized effect sizes were presented to ensure robust, comprehensive reporting of empirical result.

Results

Mediation Analysis

The current study conducted the mediation analysis grounded in Baron and Kenny's (1986) four-step approach framework. This analytical approach aimed to ascertain whether social media addiction serves as a mediating mechanism underlying the relationship between social media dependence (the independent variable) and sleep disorder (the dependent variable). The subsequent steps rigorously addressed the stated research inquiries and hypotheses, employing a methodical, evidence-based approach.

Step 1: Establishing the Total Effect (Path c)

To confirm the presence of an initial direct effect of social media dependence on sleep disorder, the latter was regressed on the former. The findings indicated that social media dependence exerts a significant positive influence on sleep disorder (B=.085, SE=.031, β=.114, t=2.769, p=.006, 95% CI [.024, .146]). This model accounted for approximately 11.3% of the variance in sleep disorder (R^2=.113), supporting hypothesis H1. This establishes the presence of a total effect to be mediated. Tests for collinearity did not reveal any violations (VIF<2). These results confirm that there is a noteworthy direct relationship warranting further mediation examination.

Step 2: Assessing the Influence of the IV on the Mediator (Path a)

The second analytical step involved ascertaining whether social media dependence significantly predicts social media addiction, the proposed mediator. The regression analysis yielded a significant positive effect (B=.083, SE=.035, β=.097, t=2.359, p=.019, 95% CI [.014, .152]), explaining approximately 30.9% of the variance in the mediator (R^2=.309), confirming hypothesis H2a. These findings verify the second prerequisite of the Baron and Kenny approach, namely that the independent variable must substantially influence the mediator. Once again, no problematic collinearity issues were detected (VIF<2).

Step 3: Effect of Mediator on DV (Path b)

Social media addiction demonstrated a substantial positive effect on sleep disorder (B=0.574, SE=0.027, β=0.655, t=21.013, p<0.001), with the model explaining 42.9% of the variance (R^2=0.429). This finding strongly supports hypothesis H2b.

Step 4: Testing Mediator's Effect on DV and Revisiting the IV's direct effect (Paths C`)

The final step incorporated both the independent variable (social media dependence) and the mediator (social media addiction) into a joint model predicting sleep disorder. The results indicated that the direct effect of social media dependence on sleep disorder was reduced but remained significant while social media addiction lingered a strong, positive predictor of sleep disorder (B=.570, SE=.027, β=.650, t=20.786, p<.001, 95% CI [.516, .624]), proving the support toward H2c. Crucially, when controlling for this mediator, the previously significant direct effect of social media dependence on sleep disorder diminished notably. The direct path coefficient declined from B=.085 to B=.038, and the corresponding t-value of 1.615 suggested that this effect may no longer achieve conventional significance thresholds. Although the reported significance value for this coefficient was not entirely consistent due to a typographical irregularity in the dataset, the inferred non-significance (or at least substantial reduction in effect size) is consistent with the presence of full mediation. Moreover, the final mediated model explained substantially more variance (R^2=.432) in sleep disorder compared to the initial direct model, signifying a considerable improvement (ΔR^2=.319).

In sum, these findings collectively, as illustrated in Table 2, corroborate Hypotheses H1, H2a, H2b, and H2c. Social media dependence directly influences sleep disorder (H1) and also independently predicts social media addiction (H2a). Moreover, social media addiction exerts a significant, positive impact on sleep disorder (H2b). Most importantly, social media addiction fully mediates the relationship between social media dependence and sleep disorder (H2c), thereby illuminating the pivotal intermediary role of addiction in understanding how dependence translates into deleterious sleep outcomes.

Table 2. *Summary Table of Key Regression Results (Mediation Analysis)*

Linear Regression Path Analysis Model Dependent Variable (DV)								
Variables	SD		SMA		SD			
	Model 1		Model 2		Model 3		Model 4	
	β	t	β	t	β	t	β	t
SMD	0.114	2.769	0.097	2.359			0.051	1.615
SMA					0.655	21.023	0.650	20.786
SE	0.031		0.035		0.027		0.024	0.027
B	0.085		0.083		0.574		0.038	0.570
Sig.	0.006		0.019		0.000		0.000	
R^2	0.113		0.309		0.429		0.432	
ΔR^2	---		---		---		0.319	
VIF	1.00 (<2)		1.00 (<2)		0.99 (<2)		0.99 (<2)	
95% CI (Lower, Upper)	(0.024, 0.146)		(0.014, 0.152)		(-0.009, 0.085)		(0.517, 0.623)	
Hypo. Test	H1 Supported		H2a Supported		H2b Supported		H2c Supported	

Note 1: SMD: Social Media Dependence; SMA: Social Media Addiction; SD: Sleep Disorder; B: Unstandardized Coefficient; SE: Standard Error; β: Standardized Coefficient; R^2: Coefficient of Determination; ΔR^2: R^2 Change; t: t-value; CI: Confidence Interval; VIF: Variance Inflation Factor

Note2: *p<0.05; **p<0.01; ***p<0.001

Elaboration of Moderation Analysis

In the baseline model (Model 1), wherein only social media dependence was entered as a predictor, findings indicated a significant positive association with sleep disorder (B=0.146, SE=0.022, β=0.114, t=2.769, p=.006; R^2=0.113). Thus, higher dependency corresponded to heightened sleep disturbances. Upon introducing social media burnout in Model 2, the model's explanatory power was incrementally enhanced (ΔR^2=0.002). Both social media dependence (B=0.160, SE=0.022, β=0.112, t=2.735, p=.006) and social media burnout (B=0.223, SE=0.022, β=0.204, t=1.064, p=.018) remained statistically significant contributors. The explained variance (R^2=0.115) confirmed that burnout supplements dependence in accounting for variations in sleep disorder. Crucially, Model 3 incorporated the interaction term (dependency × burnout). The inclusion of this term yielded a statistically significant interaction coefficient (B=0.156, SE=0.023, β=0.125, t=1.597, p=.011), indicating that social media burnout moderates the dependence–sleep disorder link. Adding the interaction increased model fit (R^2=0.119; ΔR^2=0.004), with the F-statistic for the incremental change being significant (F-change=2.552, p=.011). The 95% confidence interval for the interaction coefficient ([0.111, 0.201]) and the absence of problematic collinearity (VIF < 2.0) substantiated the robustness of this moderating effect.

This finding provides robust empirical support for Hypothesis H3, demonstrating that social media burnout indeed functions as a significant moderator of the relationship between dependence and sleep disorder. The positive valence of the interaction coefficient suggests that elevated levels of burnout serve to amplify the deleterious impact of social media dependence on sleep patterns. Moreover, when considered in conjunction with the mediation pathway through social media addiction, as illustrated in the theoretical framework, the significant moderation effect lends credence to Hypothesis H4. This suggests that the indirect effect of social media dependence on sleep disorders, operating through the mediating mechanism of social media addiction, is contingent upon the magnitude of social media burnout experienced by the individual. The final model demonstrated superior explanatory power, accounting for 11.9% of the variance in sleep disorder (R^2 = 0.119, ΔR^2 = 0.104, F(3, 585) = 3.792, p = 0.010), with all predictors

maintaining statistical significance at the conventional threshold ($p < 0.05$). The modest variance inflation factors (VIF < 1.01) indicate that multicollinearity did not pose a substantive threat to the validity of the parameter estimates. A summary of moderation analysis results was displayed in the following Table 3.

Table 3. *Summary of Moderation Analysis Results*

	SMD	SMD	SMB	SMB*SMD
	Model 1	Model 2		Model 3
B	.146	.160	.223	.156
SE	.022	.022	.022	.023
β	.114	.112	.204	.125
t	2.769	2.735	1.064	1.597
R	.114	.122		.138
R^2	.113	.115		.119
Adjusted R^2	.111	.101		.114
ΔR^2	.113	.102		.004
F Change	7.666	1.132		2.552
p	.006	.006	.018	.011

Note 1: SMD: Social Media Dependence; SMA: Social Media Addiction; SD: Sleep Disorder; B: Unstandardized Coefficient; SE: Standard Error; β: Standardized Coefficient; R^2: Coefficient of Determination; ΔR^2: R^2 Change; t: t-value
Note2: *p<0.05; **p<0.01; ***p<0.001

Furthermore, in the illustrated moderation analysis as shown in Figure 3, Social Media Burnout (SMB) significantly accentuates the positive link between Social Media Dependency (SMD) and the outcome measure. The steep gradient observed in the high-SMB group demonstrates that incremental increases in SMD yield more pronounced elevations in the outcome among individuals with elevated SMB levels. By contrast, the comparatively modest slope for the low-SMB group indicates a weaker association between SMD and the dependent variable. Hence, SMB operates as a moderator by magnifying the influence of SMD on the outcome.

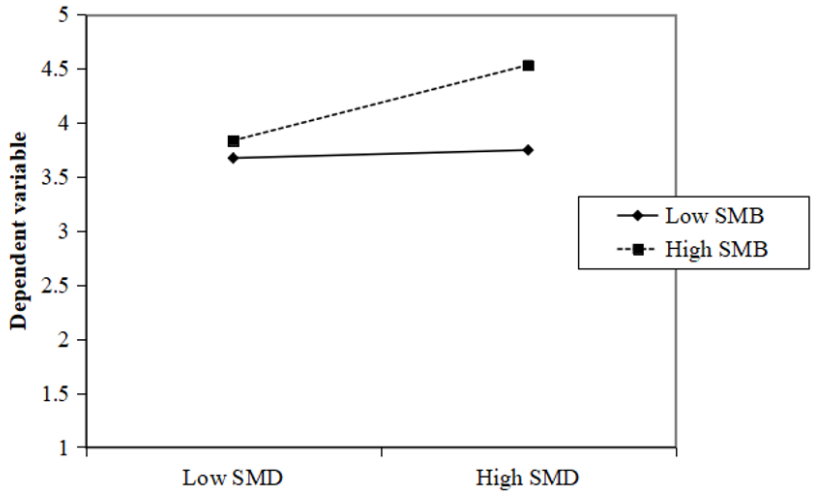

Figure 3. *Moderation Effect by Social Media Burnout*

Discussions

The outcomes of this research underscore the significant ramifications of social media dependence and addiction on sleep disorder. In line with Hypothesis 1 (H1), social media dependence revealed a notable direct association with sleep disturbance, demonstrating that increased reliance on digital platforms may compromise sleep quality (Azizi et al., 2019; Lin et al., 2021). Moreover, consistent with Hypothesis 2a (H2a), social media dependence appears to precipitate social media addiction, thereby indicating the necessity to regard dependence as a principal precursor to problematic engagement behaviors (Bilgin and Taş, 2018; Pawar and Shah, 2019). These findings echo extant empirical data, which intimate that individuals predisposed to social media dependence are particularly susceptible to developing addictive tendencies, culminating in augmented usage and adverse health outcomes (Khatimah and Ryan, 2023; Rustamov et al., 2023). The mediation analysis elucidated that social media addiction completely mediates the relationship between social media dependence and sleep disorder, thus supporting Hypothesis 2c (H2c). Specifically, once addiction was incorporated into the analytic model, the direct effect of dependence on sleep disorder was rendered non-significant (or considerably reduced), signifying that addictive behaviors serve as the chief mechanism by which dependence compromises sleep quality (Luo and Hu, 2022; Rasheed and Saba, 2023). This corroborates earlier research emphasizing the pernicious effect of compulsive online activity on circadian rhythms and subsequent disruption of sufficient rest (Lin et al., 2021; Shabahang et al., 2024). As a collective, these findings accentuate the mediating influence of social media addiction in accounting for the observed association between social media dependence and deleterious sleep outcomes (Abdalqader and Joseph, 2020; Külekçioğlu and Çetin, 2021).

Furthermore, the moderation analysis indicates that social media burnout augments the adverse impact of social media dependence on sleep disturbance, thereby corroborating Hypothesis 3 (H3). This suggests that heightened burnout amplifies susceptibility to sleep difficulties, possibly by depleting emotional resources and amplifying psychological strain (Jiang, 2021; Evers et al., 2020). Additionally, the indirect effect of dependence on sleep disorder-transmitted through addiction-is likewise dependent on burnout levels (H4), signifying that individuals experiencing pronounced burnout are especially prone to the deleterious ramifications of social media dependence and addiction (Charoensukmongkol, 2016; Yamini and Pujar, 2022). Consequently, the integration of mediation and moderation perspectives illuminates the multifaceted processes through which contemporary digital consumption patterns engender negative outcomes for sleep health.

Conclusions

The findings of this research demonstrate that social media dependence exerts a substantial influence on sleep disturbance, whilst also underscoring social media addiction as a pivotal intermediary in this association. In accordance with prior research, individuals who exhibit heightened reliance upon digital platforms are more inclined to experience compromised sleep quality (Azizi et al., 2019; Lin et al., 2021). Moreover, the mediation analysis confirmed that social media addiction fully mediates the effect of social media dependence on sleep disorder, suggesting that it is the addictive aspects of users' engagement, rather than mere dependence that engender adverse outcomes (Bilgin and Taş, 2018; Luo and Hu, 2022; Pawar and Shah, 2019; Rasheed and Saba, 2023). These results emphasise the fundamental role of addiction-related behaviours in exacerbating sleep disruptions, thus highlighting the significance of preventative strategies to curtail compulsive social media usage (Khatimah and Ryan, 2023; Rustamov et al., 2023). Additionally, social media burnout emerged as a crucial moderator in this nexus. The moderation analysis illustrated that individuals exhibiting pronounced burnout are particularly susceptible to the detrimental impact of social media dependence on sleep, conceivably owing to the intensifying depletion of emotional resources (Evers et al., 2020; Jiang, 2021). This moderating influence also extends to the indirect pathway wherein dependence engenders sleep disturbance through addiction, indicating that elevated burnout magnifies the negative repercussions of problematic media consumption (Charoensukmongkol, 2016; Yamini and Pujar, 2022). Taken as a whole, these insights shed light on the complex interplay between social media dependence, addiction, and burnout, thus offering a nuanced framework for understanding how contemporary digital usage patterns compromise sleep health.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Institutional Review Board Statement

This study was conducted in strict accordance with the ethical standards for research involving human participants and aligned with the principles of the Declaration of Helsinki. The research protocol, titled *Digital Dependency and Sleep Deprivation: The Dual Roles of Addiction and Burnout in Modern Media Consumption*, authored by Li-Wei Wei (PhD), was reviewed and approved by the Human Research Ethics Committee (HREC) of Dhurakij Pundit University (Approval Code: DPUHREC011/67EX, Date of Approval: February 10th, 2025), with the outcome of minor modifications required. Prior to participation, all participants provided informed consent after being fully informed about the study's purpose, procedures, potential risks and benefits, and their right to withdraw at any time without penalty. All ethical principles were upheld throughout the study, including the protection of participants' confidentiality, voluntary engagement, and secure handling of data in compliance with applicable institutional and legal guidelines.

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Prediction of Academic Success Based on Teaching Quality Using Fuzzy Logic

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Abstract: This research aims to examine the impact of the quality of teaching on the success of vocational students, focusing on professional-applicative subjects in the field of information technology, as well as on general education subjects. The quality of teaching was analyzed through six factors: comprehensibility of the teaching content, applicability of the material, quality of the teaching material, teacher's commitment, working atmosphere and objectivity of assessment. The academic success of students is represented by the course grade. An adaptive neuro-fuzzy system, ANFIS, was used to model the relationship between the aforementioned factors and academic achievement, which combines the advantages of fuzzy logic and neural networks. Data were collected through a structured questionnaire with a Likert scale, and the model was trained and evaluated using soft computing techniques. The results show that the quality of the teaching material, the dedication of teachers and the working atmosphere have the greatest influence on the success of students. These factors were singled out as the most significant predictors of success within the ANFIS model. The findings indicate the need for a systematic approach to improving the quality of teaching in professional studies and confirm the usefulness of artificial intelligence in the analysis of educational data.

Keywords: *Teaching quality, Professional studies, Fuzzy logic, Anfis, Soft computing.*

Introduction

Academic success is one of the key indicators of the effectiveness of the educational process and is most often measured by achieved grades, passing or achievement on standardized tests. In the literature, academic success is defined as the degree to which the student has adopted the intended learning outcomes (Villar, A., and de Andrade, C. R. V. 2024). It is influenced by several factors: individual characteristics of students (prior knowledge, motivation, learning styles), contextual factors (financial support, family support), but also factors related to the teaching process itself, such as the quality of teaching, the approach of teachers and the availability of teaching resources (Ligia, E. et al. 2024). Research shows that the quality of teaching is one of the most important predictors of academic achievement, especially in vocational education.

Teaching quality is a complex category that includes several aspects of the teaching process. In this research, the quality of teaching is conceptualized through six basic factors: comprehensibility of the teaching content, applicability of the material in practice, quality of the teaching material, teacher's commitment, working atmosphere during the lesson and objectivity of assessment. These factors reflect students' perception of the effectiveness of the teaching process and are often used as indicators in the evaluation of teaching quality in higher education (Zhao, H., and Zhang, F. 2025). Each of the above features has a specific role in creating an educational environment that encourages academic success.

The use of artificial intelligence and soft computing methods in the analysis of educational data is becoming increasingly common in modern research. These techniques enable the analysis of complex

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and ill-defined relationships between educational variables, taking into account uncertainty and subjectivity in data derived from surveys or other sources (Zogopoulos, K. et al. 2025). Soft computing approaches, such as neural networks, genetic algorithms and fuzzy logic, enable the construction of models that provide a better understanding of educational processes, as well as the prediction of learning outcomes. The application of these techniques in the analysis of teaching quality enables obtaining valuable insights that can be used to make strategic educational decisions.

Fuzzy logic represents a mathematical approach to modeling uncertainty and imprecision that allows describing complex systems using linguistic variables and degrees of belonging. Unlike traditional binary logic, fuzzy logic allows values to belong to multiple categories at the same time, which is particularly useful in the analysis of subjective assessments such as the perception of teaching quality. The basic elements of a fuzzy system include input fuzzification, rule set definition, inference mechanism and output defuzzification (Celikyilmaz, A., and Türksen, I. B. 2009). In this research, fuzzy logic was applied within the ANFIS model in order to obtain a prediction of academic success based on several input factors that describe the quality of teaching.

Numerous studies point to the importance of the quality of teaching as one of the key factors in the academic success of students. Studies in the field of educational psychology and pedagogy point to a positive correlation between the comprehensibility of lectures, the motivation of teachers and the achieved grades of students. On the other hand, research in the field of educational analytics increasingly includes the application of soft computing techniques, such as fuzzy logic and ANFIS models, in the analysis of educational processes (Mojsilović, M. et al. 2025). In the literature, there are works that apply these methods for predicting success, identifying at-risk groups of students and optimizing teaching strategies. However, there is a limited number of researches that are specifically focused on professional studies and professional-applicative subjects in the field of information technologies, which indicates the existing research gap that this paper seeks to fill.

Modern education systems face challenges in how to improve the quality of teaching and improve student success. Especially in the context of vocational studies in the field of information technology, the quality of teaching is a key factor that can affect the level of acquired knowledge and acquired competencies. Effective recognition and quantification of teaching quality factors that contribute the most to students' academic achievements is extremely important for planning and improving educational processes.

Traditional methods of educational data analysis are often not sufficient for accurate modeling of complex and interdependent relationships between various factors of the educational process (Baker, R. S. et al. 2016). In this context, the application of soft computing techniques, and especially fuzzy logic, provides an opportunity for a better understanding of the uncertainty and subjectivity that is present in teaching quality assessments.

The goal of this research is to develop a model for predicting the academic success of students based on their perception of the quality of teaching, using a fuzzy logic approach. The research is focused on professional-applied courses in professional studies of information technologies, because these courses represent the key link between theoretical knowledge and its practical application, as well as on general education courses.

The paper includes an analysis of six teaching quality factors: comprehensibility of the teaching content, applicability of the material, quality of the teaching material, teacher's commitment, working atmosphere and objectivity of assessment. As an output variable, the academic success expressed through the course grade was taken. The model based on fuzzy logic enables the prediction of success based on the input parameters that represent the student's perception of various aspects of teaching quality.

Through this research-problem orientation, the work aims to contribute to the improvement of teaching practices and the process of making pedagogical decisions in professional studies.

Previous research in the field of education has most often focused on the analysis of individual factors that influence academic success, while there is a noticeable lack of studies that holistically observe the quality of teaching, especially in the context of vocational studies in information technology (Mojsilović, M. et al. 2023). Also, the application of advanced soft computing techniques, such as fuzzy logic and adaptive neuro-fuzzy inference systems (ANFIS), is still insufficiently represented in educational analytics.

The original contribution of this research is reflected in the development of a predictive model that integrates student perception of teaching quality with artificial intelligence techniques in order to assess academic success. The results of the work can serve as a basis for making decisions aimed at improving educational practices, especially in the segment of professional education.

Materials and Methods

The research was conducted at the Academy of Vocational Studies in Šumadija - Trstenik Department. The sample included a total of 155 vocational students attending various study programs in the field of information technologies. Special attention is paid to the inclusion of students who attend general education subjects, such as English and Mathematics, but also those who attend professional-applied subjects, in accordance with their teaching curricula.

Within the group of students attending professional-applicative subjects, students from different modules and study programs were surveyed, which enabled us to gain insight into the perception of the quality of teaching at different levels and areas of professional education.

For the purposes of data collection, a structured questionnaire consisting of six questions was used, each of which was aimed at one of the key factors presented in Table 1. Students rated their experiences using a ten-point Likert scale, where the value 1 indicated complete disagreement and 10 complete agreement with the given statements.

The survey was completed by students from different years of study and different modules, which additionally contributed to the diversity of the sample and enabled a broader analysis of the perception of teaching quality in the context of different types of subjects and educational experiences.

In order to examine in detail the impact of teaching quality on student achievement, key input factors that reflect different aspects of the teaching process have been identified. The selection of these factors is based on theoretical foundations and previous research in the field of educational pedagogy and educational analytics. Special emphasis is placed on the specifics of professional-applied and general education subjects in vocational studies, in order to ensure the relevance and reliability of the analysis in relation to different educational contexts. The presented factors represent the basis for further analysis and modeling, with the aim of verifying their connection with the academic achievements of students. Table 1, which follows, shows all the input factors that were included in the research and used in the construction of the predictive ANFIS model.

In this research, the quality of teaching was evaluated based on six key factors that, according to the relevant literature, have a significant impact on the academic achievement of students. The first factor, the comprehensibility of the teaching content, refers to the clarity and precision in the presentation of the material, which directly affects the acquisition of knowledge, especially in general education subjects. The applicability of the material represents the ability of students to connect what they have learned with practical situations and real problems, which is especially important in professional-applied courses. The quality of the teaching material includes the availability, up-to-dateness and adaptability of the material to the needs of students, which facilitates the learning process and increases academic success. The commitment of teachers reflects the level of engagement in planning and implementation of teaching, as well as the willingness to provide additional support to students, which positively affects their motivation and results. The working atmosphere during classes includes mutual interaction and communication between students and teachers, creating a stimulating environment for learning. Finally, the objectivity of assessment refers to fairness and transparency in the evaluation of knowledge, which encourages students to feel fair and additional motivation to achieve better results. These factors were integrated into a predictive model with the aim of examining their overall and individual impact on the achievement of vocational students.

Table 1. *Input and output parameters*

Input and output	Parameters	Scope
Input 1	Understandability	1-10
Input 2	Applicability	1-10
Input 3	Quality of teaching and teaching materials	1-10
Input 4	Teacher commitment	1-10
Input 5	Working atmosphere	1-10
Input 6	Objectivity of assessment	1-10
Output	Student achievement (grade)	5-10

Adaptive neuro fuzzy network – ANFIS

Artificial neural networks represent one of the most important models in the field of artificial intelligence, developed with the aim of imitating the process of information processing in the human brain (Shanmuganathan, S. 2016). They consist of interconnected nodes, known as artificial neurons, with each neuron functioning as a basic processing unit with its own local memory for storing and processing data. Communication between neurons takes place through connections that transmit numerical values, which enables the flow and transformation of information through the network. Mathematically speaking, neural networks are based on models that imitate the functional characteristics of biological neurons (Abdi, H. et al. 1999, Buchaniec, S. et al. 2021). In a biological system, a neuron consists of a body, dendrites and an axon - where the dendrites serve to receive information, the body to process them, and the axon to transmit signals to other neurons (Stevens, C. F. 1979). In the analog model of an artificial neural network, this process is realized through a perceptron - a logical unit that receives input values, processes them and generates an output signal. Such an architecture allows neural networks to be widely used in solving complex tasks of analysis, classification and prediction in various fields, including education (Mehrotra, K. 1997).

The artificial neuron model represents a simple processing unit consisting of three basic levels: input, hidden and output. The input level adjusts the data for processing, the hidden level ensures the nonlinearity of the system, while the output level generates and interprets the final results, Figure 1. Information processing is performed by applying a suitable mathematical function to the input data, which enables the generation of an output signal (Shanmuganathan, S. 2016).

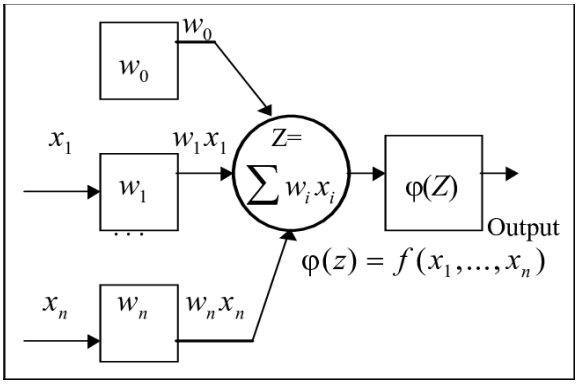


Figure 1. Mathematical model of an artificial neuron (Fountas, Z. 2011)

Figure 1 shows the mathematical model of an artificial neuron, where:

$x_{1...n}$ – input data, through which the neuron receives the signal,
n – the total number of those values,
$w_{1...n}$ – weighting coefficients and
φ( ) – activation function.

The input signals are multiplied by the corresponding weighting coefficients, whereby each signal x_i is multiplied by its weighting factor w_i. After that, all the products are combined in an adder that generates the total input signal of the network.

$$x_1w_1 + x_2w_2 + \cdots + x_nw_n = \sum_{i=1}^{n} x_iw_i$$

$$\text{net} = \sum_{i=1}^{n} x_iw_i$$

The resulting value, known as the weighted sum or total excitation of the neuron, does not represent the final output of the neuron. To form the output signal, this value is passed through the activation function, which is responsible for transforming it into the output value labeled “out”. The activation function

determines the response of the neuron to the input signal and is usually denoted by the symbol φ(net). Depending on the type of neural network, different types of activation functions are used. In the simplest case, when the weighted sum exceeds the defined activation threshold θ, the output value of the neuron goes into the active state, usually with a value of 1, which indicates the activation of the neuron (Haykin, S. 1998).

$$out = \varphi (net - \theta)$$

In artificial neural networks, activation functions convert a weighted sum of inputs into a corresponding output signal and are most often non-linear, which enables the network to solve complex problems. Sigmoid functions such as logarithmic, arctangent or Gaussian functions are most commonly used, especially when the output values are limited. The weight coefficients are adjusted during the learning process through repeated iterations, where the network compares the output values with the expected results and corrects the weights to minimize the error. This procedure allows the network to gradually improve the accuracy of its predictions and achieve the desired behavior (Anđelković B. 2006).

Law of learning

The law of learning is a mathematical model that defines the way of adjusting the weighting coefficients, w_{ij}, between neurons in the network (Adamović, V. M. 2018), where the weight reflects the strength of the interconnectedness of the neurons. The process of updating the weights takes place in accordance with the defined learning rules, among which one of the most commonly applied is the Delta rule, defined by the appropriate formula.

$$\Delta\omega_{ji} = \eta * \gamma_{cj} * \varepsilon_i$$

Where is it $\Delta\omega_{ji}$ connection weight adjustment value from the neuron j to neurons i, calculated according to:

$$\Delta\omega_{ji} = \omega_{ji}^{nova} - \omega_{ji}^{stara}$$

Where is it:
η is the learning coefficient,
γ_{cj} value of the output calculated in the neuron j,
ε_i is the raw error calculated according to,
$\varepsilon_i = \gamma_{ci} - \gamma_{di}$, where is it γ_{di} – the actual output used to calculate the error.

The delta rule, also known as the least mean square rule, aims to minimize the total network error by adjusting the weighting coefficients (Razeghi, S. A. 2022). The key learning parameters are the learning coefficient and the inertia factor, momentum. The learning coefficient determines how much the weights change at each learning step - higher values speed up the process, but may cause instability. Momentum contributes to learning stability by preventing sudden changes in weights, reducing error oscillations, and helping to overcome local minima (Chong, D. J. S. et al. 2023).

The rule base of the ANFIS network consists of if-then rules. A system with two inputs and one output is used to describe these rules:

The rule 1: IF ((x is A_1) and (y is B_1)) THEN (z is f_1)
The rule 2: IF ((x is A_2) and (y is B_2)) THEN (z is f_2)

The following notation is used to define these rules:
x, y – input sizes,
z – output size,
A_i , B_i (i=1,2) – fuzzy sets (linguistic variables) and
f_i (i=1,2) – exits the inference system.

The first layer receives input quantities and transforms them into fuzzy values according to membership functions (Chong, D. J. S. et al. 2023).

$$Q_{1,i} = \mu_{Ai}(x) \qquad i = 1,2, \ldots n$$

$$Q_{1,i} = \mu_{Bi}(x) \qquad i = 1,2, \ldots n$$

Where: x, y – input sizes; A_i , B_i (i=1,2) – fuzzy sets (linguistic variables); μ_{Ai} , μ_{Vi} – membership functions.

There are several types of membership functions. In this research, the bell-shaped membership function was used because this function has the greatest ability to regress non-linear data. A bell-shaped membership function, the Bell function is defined as follows:

$$\mu(x) = bell(x; a_i, b_i, c_i) = \frac{1}{1+\left[\left(\frac{x-c_i}{a_i}\right)^2\right]^{b_i}}$$

where x is the input quantity, while ai,bi,ci are the given parameters.

The second layer multiplies the phase signals from the first layer and, as a rule, gives the activation power – w_i.

$$Q_{2,i} = w_i = \mu_{Ai}(x) * \mu_{Bi}(x) \quad i = 1,2$$

The third layer is the rule layers where all signals from the second layer are normalized:

$$Q_{3,i} = \overline{w}_i = \frac{w_i}{\sum w_i} \qquad i = 1,2$$

The fourth layer is adaptive and provides rule inference and all signals are converted to correct values.

$$Q_{4,i} = \overline{w}_i * f_i \qquad i = 1,2$$

Functions f_1 and f_2 are functions from the rule base IF – THEN:

The rule 1: IF ((x is A_1) and (y is B_1)) THEN ($f_1=p_{1x}+q_{1y}+r_1$)
The rule 2: IF ((x is A_2) and (y is B_2)) THEN ($f_2=p_{2x}+q_{2y}+r_2$),

where are they p_i , q_i , r_i (i=1,2) – rule conclusion parameters (consequential parameters).

The fifth layer is fixed and it sums all the signals and displays a fixed output value:

$$Q_{5,i} = f_{out} = \sum \overline{w}_i * f_i$$

The final output can also be presented in the following way:

$$f_{out} = \overline{w}_1 * f_1 + \overline{w}_2 * f_2 = \frac{w_1}{w_1 + w_2} * f_1 + \frac{w_2}{w_1 + w_2} * f_2 =$$

$$= (\overline{w}_1 * x) * p_1 + (\overline{w}_1 * y) * q_1 + (\overline{w}_1) r_1 + (\overline{w}_2 * x) * p_2 + (\overline{w}_2 * y) * q_2 + (\overline{w}_2) r_2$$

Modeling of the fuzzy inference system using neural networks enables automatic determination of membership function parameters based on input-output data (Buragohain, M. et al. 2008). The ANFIS network in the first forward pass uses the least squares method to calculate the consequent parameters, while in the backward pass the assumption parameters are updated using the gradient descent method. Training and testing of the ANFIS model were carried out in the Matlab software environment, using the collected experimental data. The accuracy of the model was assessed using the root mean square error, RMSE, which serves as the basic criterion for predictions.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} (P_i - Q_i)^2}{n}}$$

Where are they P_i and Q_i experimental and calculated data, respectively, and n is the total number of data.

As part of this research, the processing of the collected data was realized using the software

package Matlab, using tools for neuro-fuzzy logic. Before starting the process of processing and training the model, it was necessary to perform several preparatory steps. The first step involved loading a data set containing the values of all input factors and output variables, with the output being in the last column. Then, the initial structure of the model was defined, where the FIS (Fuzzy Inference System) of the Sugeno type with one output was applied, within the framework of the ANFIS architecture (Bakri, R. et al. 2020). For the optimization of membership function parameters, a hybrid method was chosen, which combines the least squares method for determining the consequent parameters and the gradient descent method for setting the assumptions. The learning process parameters involved setting the number of epochs and specifying an acceptable error margin, with training being terminated once either condition was met. Following the training phase, model validation was carried out using an independent test dataset, excluded from training, to evaluate the model's generalization ability. Furthermore, a comprehensive analysis of the complete dataset was conducted. The outcomes of the modeling are illustrated graphically and explained in detail in the subsequent sections of the paper. For each individual input, the model was trained separately, and the performance assessment was performed through the calculation of several statistical indicators: mean error value, SV, mean deviation, SD, mean square error, MSE, root mean square error, RMSE and Pearson's linear correlation coefficient, R. Special attention was paid to the RMSE and R values as the main indicators of model accuracy and reliability. A low RMSE and a high value of the R coefficient (over 0.8) were considered indicators of a good predictive ability of the model. The influence of individual input factors was evaluated based on the RMSE value, with the factor with the smallest error during training identified as the most relevant for the prediction of the output size (Ćalasan, M. et al. 2020). Monitoring the RMSE value through the training and testing phases enabled the detection of potential overfitting, while the value of the coefficient R served to check the degree of linear association between the actual and predicted output results (J.-S. R. Jang 1993).

Results

As part of this research, the influence of the quality of teaching on student achievement, expressed through achieved grades in courses, was analyzed. Special attention was focused on the examination of differences in the influence of individual teaching quality factors on the achievement of students attending professional-applied and general education subjects at vocational studies. The collected data were processed using statistical methods and the adaptive neuro-fuzzy system, ANFIS, which enabled a precise analysis of the relationship between the investigated factors.

Results of the model for professional-applicative subjects in professional studies

The research results shown in Table 2 refer to the performance of the ANFIS model during the process of training, testing and overall analysis of all data. By analyzing the value of the root of the mean square error for each of the input factors, it was determined which factor has the greatest influence on the achievement of students in professionally applied subjects. The obtained results show that input factor number 4 - teacher's commitment - achieved the lowest value of RMSE through all stages of modeling, which indicates that this factor has the most significant predictive influence on the achievement of students in professional studies. This result confirms the assumption that the engagement and commitment of teachers play a key role in achieving better educational outcomes.

Table 2.*The influence of one entry on the exit for professionally applied subjects in vocational studies*

Input no. 4
TRAINING ERROR SV = 0.000000 SD = 0.326350 MSE = 0.105795 RMSE= 0.325261
TEST ERROR SV = 0.097173 SD = 0.251535 MSE= 0.070369 RMSE = 0.265272
ALL DATA SV = 0.014823 SD = 0.3174 MSE = 0.10039 RMSE = 0.31684

Figure 2 shows the results of error analysis in the stages of training, testing and processing of the entire data set, obtained by applying the ANFIS model. The graphs shown allow detailed monitoring of the model's behavior and its ability to accurately predict students' academic achievements at different stages.

Based on the displayed results from the picture, key statistical indicators were calculated for the purpose of analyzing the performance of the ANFIS model. The values of these parameters are presented individually for the training, testing, and overall dataset. Such a multi-level evaluation enables a thorough examination of the model's accuracy and reliability across different phases of the analysis. Graphical representations in the figure illustrate the difference between input and output values, the distribution of errors and variations during all analyzed examples, thus confirming the stability and consistency of the developed ANFIS system in predicting the academic achievement of students.

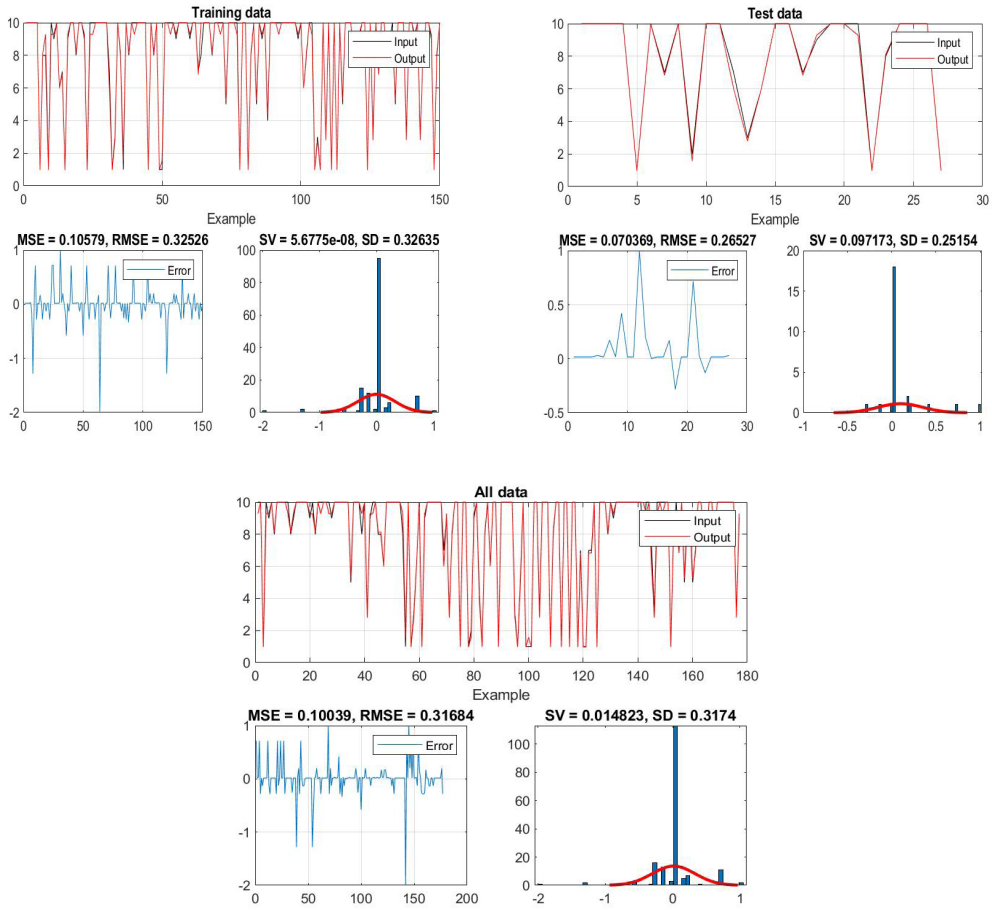


Figure 2. Impact of a single input on achievement - results of training, testing and aggregate data of the ANFIS network

Figure 3 shows the regression analysis that assessed the accuracy and reliability of the developed ANFIS model. This analysis shows the degree of agreement between predicted and actual values. High values of the linear correlation coefficient for training R=0.99438, testing R=0.99721 and all data together R=0.99477 indicate high accuracy of the model. Figure 4 shows a graphic representation of the results for the training data set, where the real values are marked with red stars, and the ANFIS model output with blue dots. A clear match between these values confirms the success of the training process and the ability of the model to accurately predict the output results. These visual representations further facilitate the observation of potential deviations and contribute to a better interpretation of the model's performance.

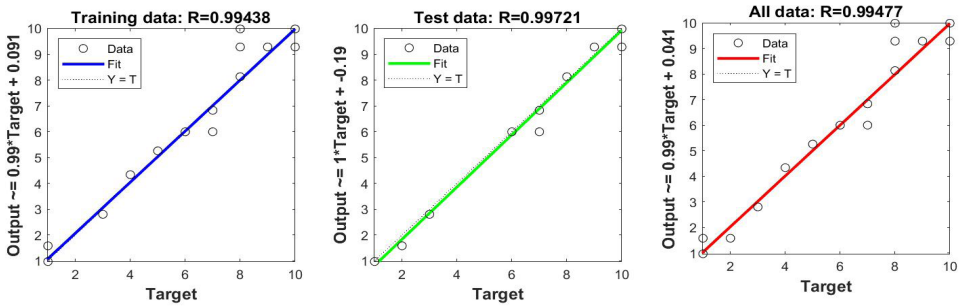


Figure 3. Linear regression of training, test and all data - influence of one input

The high correlation coefficients reported in the regression analysis (R values close to 1) demonstrate a very strong linear relationship between the predicted and actual values. This means that the ANFIS model is able to accurately capture the underlying patterns in the data with minimal error. Since the values for training, testing, and all data are consistently high, it indicates not only that the model has learned effectively during training, but also that it generalizes well to unseen data. Therefore, these results strongly support the reliability and accuracy of the ANFIS model in predicting student success.

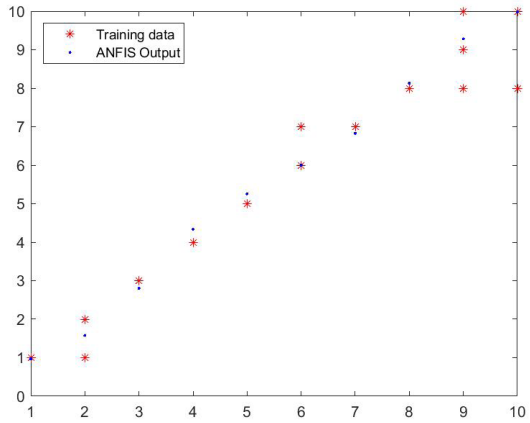


Figure 4. Graphical interpretation of training data - impact of a single input

By analyzing the results obtained using the ANFIS model, it was determined that the combination of the factors quality of teaching material and teacher's commitment has the greatest impact on the achievement of students in professional studies, shown in table 3. These two factors together showed the lowest value of the root mean square error RMSE during the modeling process, which indicates their key predictive value in relation to the other analyzed input variables. The obtained results confirm the importance of adequately prepared and relevant teaching content, as well as the high level of teacher engagement in the education process. Their joint influence on students' achievements is especially evident in professional-applied subjects, where well-designed materials and a dedicated approach to teaching and mentoring have a direct effect on student success. These findings provide important guidelines for improving the teaching process through continuous investment in the development of educational materials and encouraging greater professional engagement of teaching staff.

Table 3. *The impact of two inputs on the output for professionally applied subjects in vocational studies*

Input no. 3 - 4
TRAINING ERROR SV = 0.000000 SD = 0.156873 MSE = 0.024445 RMSE= 0.156350
TEST ERROR SV = 0.011108 SD = 0.311665 MSE = 0.093661 RMSE= 0.306041
ALL DATA SV = 0.0016949 SD = 0.18762 MSE = 0.035004 RMSE = 0.18709

Figure 5 gives a detailed view of the errors made during the different stages of modeling, with special emphasis on the influence of two combined factors. This comprehensive analysis allows a better understanding of how errors manifest themselves in different conditions and phases of the process, which is important for evaluating the stability and reliability of the model.

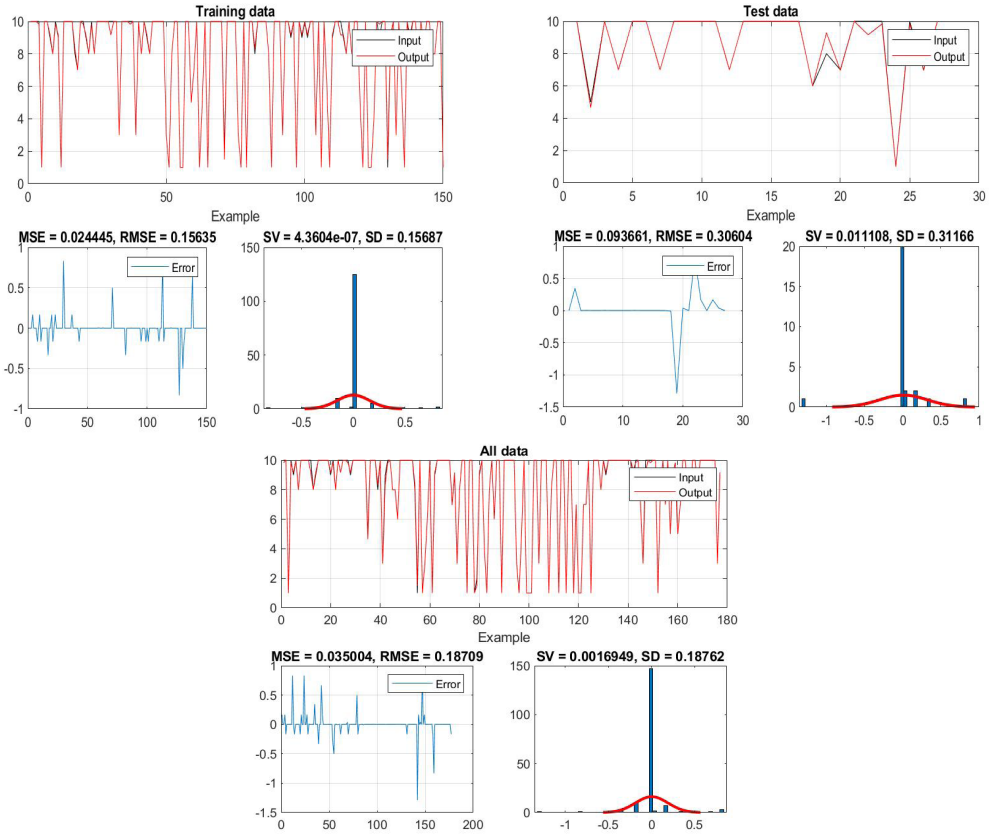


Figure 5. Effect of two inputs on achievement - results of training, testing and aggregate data of the ANFIS network

Figure 6 shows the regression analysis for the different stages of the ANFIS model: training set, test set and total data set. Each graph shows the relationship between actual (Target) and predicted (Output) values.

For the training data, an extremely high value of the linear correlation coefficient R=0.99882 was obtained, which indicates an almost ideal agreement between the real and modeled values. The graph shows that the adjustment line, the blue line, very precisely follows the ideal diagonal (the Y=T line), which confirms the high level of accuracy during model training.

With the test data, the value of the correlation coefficient is R=0.98997, which also shows a very good predictive ability of the model even on data that was not used in the training phase. The green fitting line shows minimal deviations from the ideal line.

For the total data, the correlation coefficient is R=0.99817, which confirms the general reliability and stability of the model when processing the entire data set.

All three analyzes together indicate that the developed ANFIS model shows a high degree of accu-

racy, with very small deviations between predicted and actual values throughout all stages of evaluation.

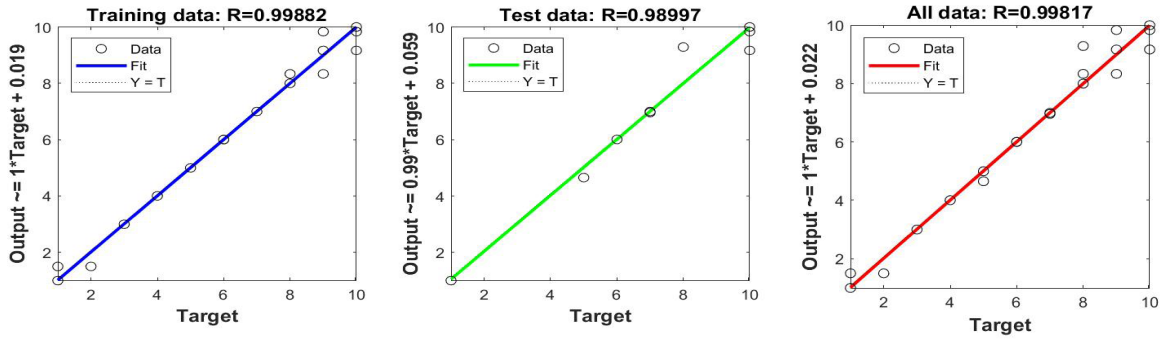


Figure 6. Linear regression of training, test and all data - influence of two inputs

In Figure 7, a 3D surface graphic is presented that illustrates the dependence of the output value, output, on two input parameters, input1 and input2, within the framework of the developed ANFIS model.

This visualization enables an overview of how different combinations of input factor values affect the output result, i.e. student achievement. Areas with different intensities of output values are clearly visible, while the colors on the surface are an indicator of output strength - from lower, blue shades, to higher values, yellow shades.

The surface form of the graph shows a non-linear and complex relationship between the input variables and the output, which confirms the justification of the application of soft computing techniques, such as ANFIS, for modeling such systems. Areas with pronounced increases in output indicate combinations of input factors that contribute most to achievement, while flat or sloping surfaces indicate lower influence.

This three-dimensional representation provides additional insight into the behavior of the model and facilitates the interpretation of the interdependence between the analyzed teaching quality factors.

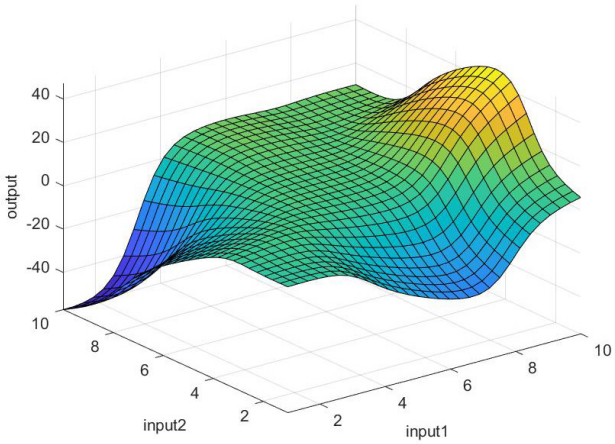


Figure 7. Graphical interpretation of training data - impact of two inputs

Table 4 shows the results of the analysis of the impact of the three most important factors of teaching quality on the academic achievement of students in professional studies. The results clearly indicate that the quality of the teaching material, the dedication of the teachers and the working atmosphere during classes showed the greatest degree of influence on the students' grades, compared to the other examined factors. The obtained results indicate that the positive perception of students about the clarity and quality of teaching materials, the engagement and motivation of teachers, as well as the creation of a stimulating working atmosphere significantly contributes to their success in professional and applied subjects. These findings provide important guidelines for improving the teaching process and can serve as a basis for further pedagogical guidelines to raise the level of academic success.

Table 4. The impact of three inputs on the output for professionally applied subjects in vocational studies

Input no. 3 - 4 - 5
TRAINING ERROR SV = 0.000000 SD = 0.057928 MSE = 0.003333 RMSE = 0.057735
TEST ERROR SV = 0.117917 SD = 0.560167 MSE = 0.316069 RMSE = 0.562200
ALL DATA SV = 0.017987 SD = 0.22584 MSE = 0.051039 RMSE = 0.22592

Figure 8 shows the result of the analysis of errors obtained during the training, testing and processing of the entire data set. The presented data enable the evaluation of the behavior of the model in different stages of processing, with a focus on the accuracy and stability of the prediction of the academic achievement of students. By analyzing error values, such as RMSE and MSE, it is possible to see the consistency of the model and its ability to generalize to new data. The obtained results provide a basis for assessing the reliability of the applied model and its applicability in predicting educational outcomes.

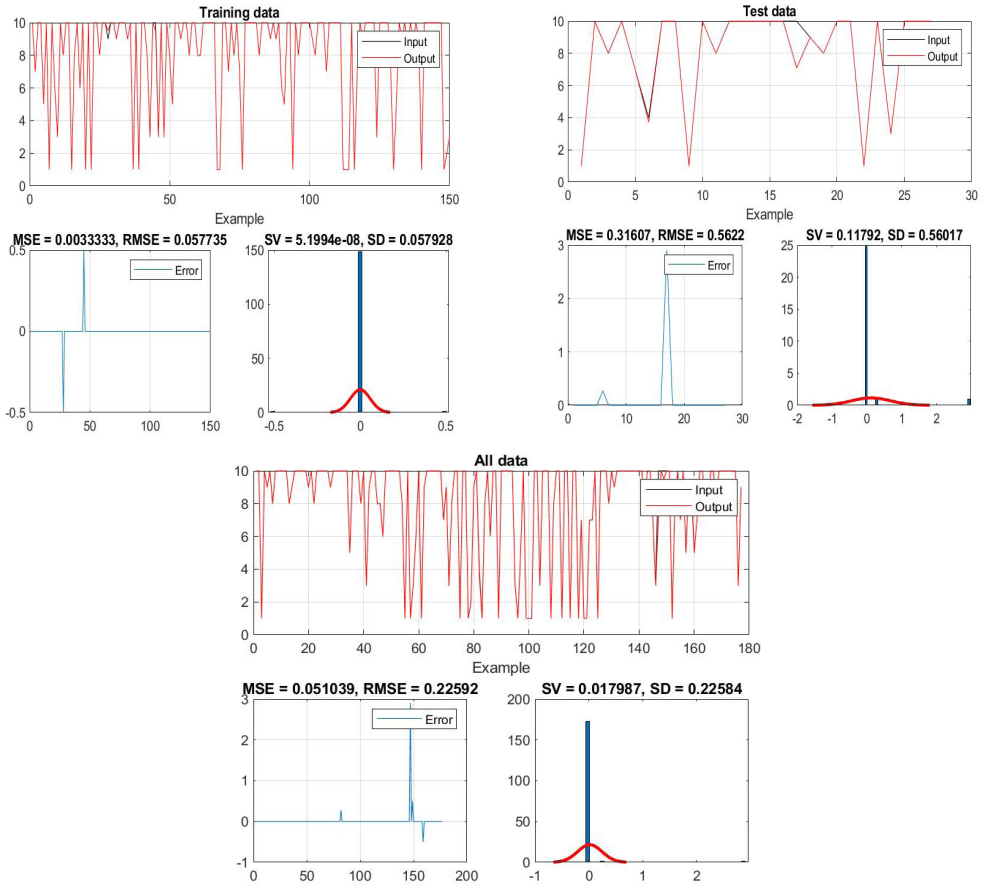


Figure 8. Impact of three inputs on achievement - results of training, testing and overall ANFIS network data

Linear regression analysis was used to assess the degree of association between actual student achievement values and output values generated by the ANFIS model. The linear correlation coefficients obtained during training R=0.99983, testing R=0.98414 and for the entire data set R=0.99735 indicate the high reliability and precision of the ANFIS model in predicting academic success, shown in Figure 9.

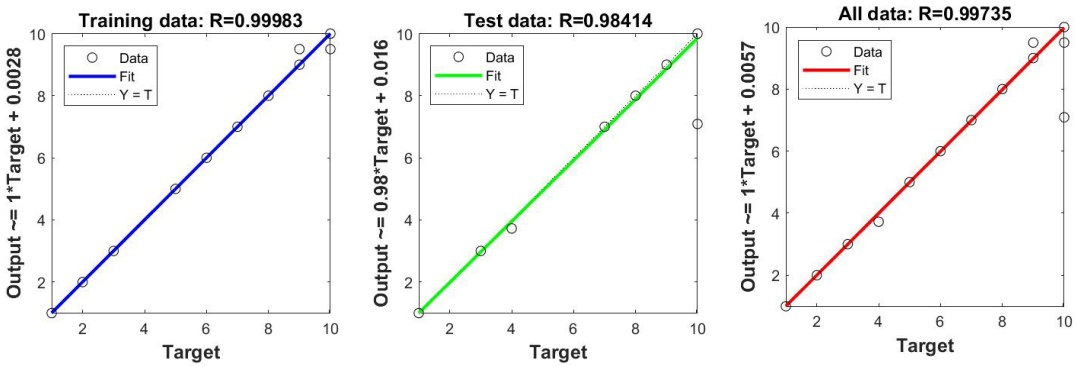


Figure 9. Linear regression of training, test and all data - influence of three inputs

The high linear correlation coefficients (R values close to 1) suggest that the ANFIS model has a strong ability to predict academic success with high reliability and precision. They indicate that the model's predicted values are very closely aligned with the actual student achievement values, confirming both its accuracy and its effectiveness in generalizing to new data. The graphical interpretation of the training data for the three input factors is shown through a three-dimensional (3D) diagram illustrating the interdependence between the input variables and the output value of the model, shown in Figure 10. The horizontal axes show the values of the two input factors (the quality of the teaching material and the teacher's commitment), while the vertical axis shows the output - the prediction of student achievement. The graph surface clearly shows how changing the input factors affects the output variable, allowing a visual insight into the complex non-linear relationships that the model successfully detected during the training process.

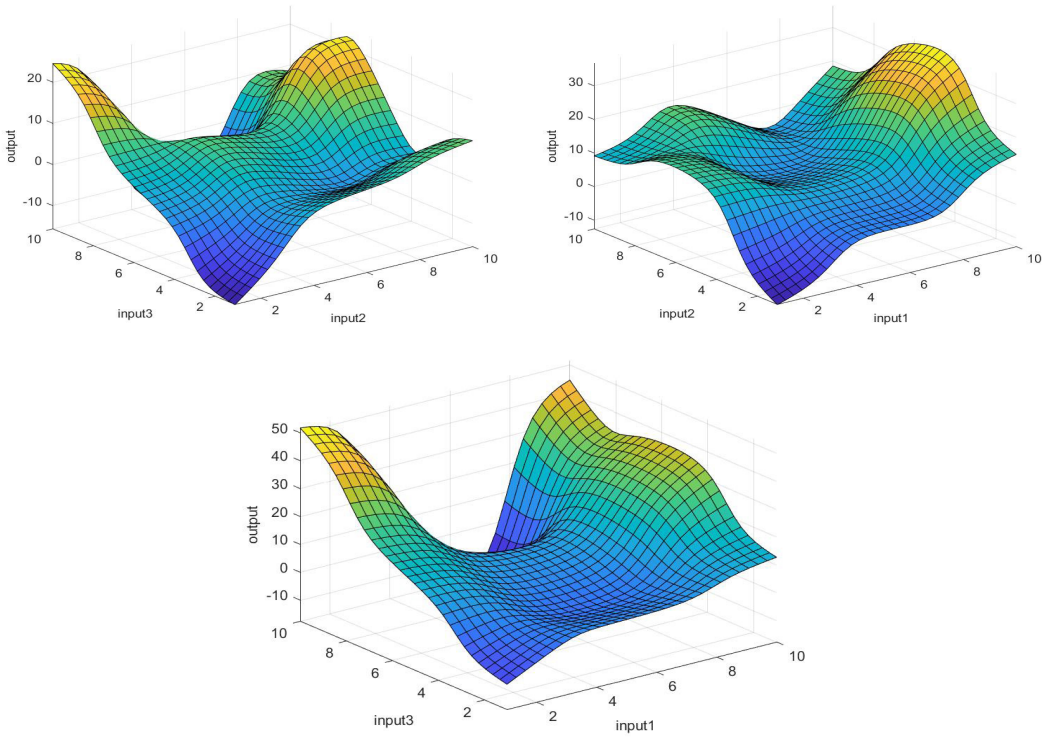


Figure 10. Graphical interpretation of training data - impact of three inputs

Model results for general education subjects in vocational studies

When analyzing the most influential factor for the achievement of students in general education subjects, the results shown in Table 5 clearly indicate that the comprehensibility of the teaching content

has the greatest influence. This factor produced the lowest error value during training, highlighting its crucial role in influencing students' achievement in these subjects. The findings emphasize the significance of clear and accurate knowledge transfer for improving educational outcomes in general education courses.

Table 5. The impact of one entrance on the exit for general education subjects in vocational studies

Input no. 1
TRAINING ERROR SV = 0.000000 SD = 0.135392 MSE= 0.018262 RMSE= 0.135136
TEST ERROR SV = -0.045601 SD = 0.199284 MSE= 0.040949 RMSE= 0.202358
ALL DATA SV = -0.0068693 SD = 0.14732 MSE = 0.021679 RMSE = 0.14724

Figure 11 shows a detailed analysis of errors in different stages of the process, with special emphasis on the influence of one factor in general education subjects. Error analysis across training, testing, and the entire data set demonstrates the model's satisfactory ability to recognize patterns and trends, providing valuable insights into examinee performance in the context of observed factors.

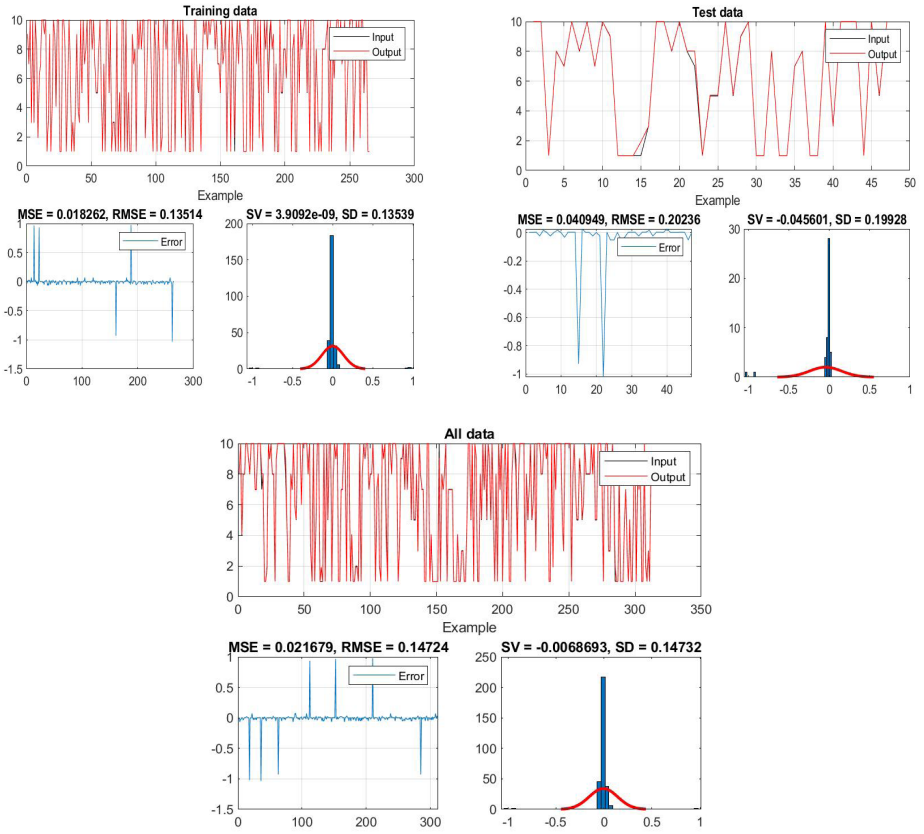


Figure 11. Impact of a single input on achievement - results of training, testing and aggregate data of the ANFIS network

Figure 12 shows the results of the regression analysis and the reliability of the model with the influence of one factor on general education subjects, which helps to assess its accuracy in predicting the target size. The linear correlation coefficient for the training data is R=0.99927, for the test R=0.99859, and for all data R=0.99915. Figure 13 graphically shows the training data and outputs of the ANFIS model, showing good matching and successful model training with this model as well.

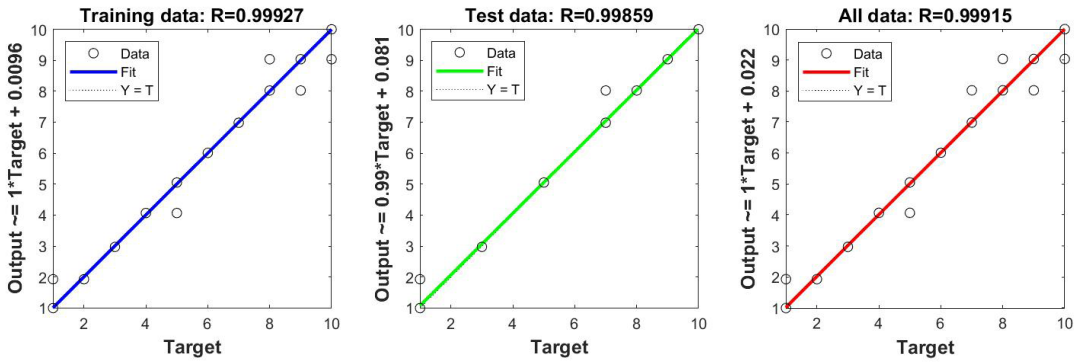


Figure 12. Linear regression of training, test and all data - influence of one input

The correlation coefficients can be influenced by several factors, including the size and diversity of the training and testing datasets, the presence of noise or outliers in the data, and the model's ability to capture underlying patterns without overfitting. Slight differences between training, test, and full dataset R values may reflect how well the model generalizes to unseen data. If the test R value is close to the training R value, as in this case, it suggests that the model has strong predictive power and generalizability. Larger discrepancies, however, would indicate possible overfitting or insufficient representation of variability in the training set.

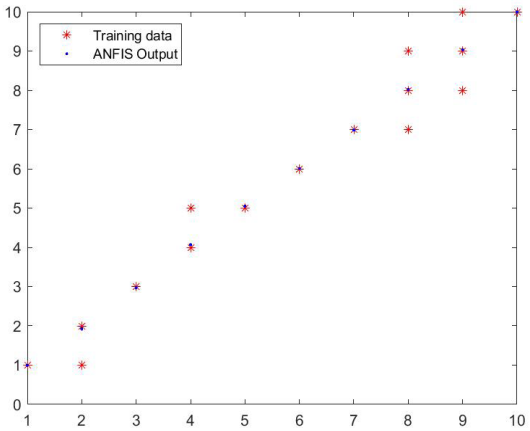


Figure 13. Graphical interpretation of training data - impact of a single input

The analysis of the influence of combined factors on the achievement of students in general education subjects, shown in Table 6, showed that the combination of the comprehensibility of the teaching content and the commitment of the teacher has the greatest impact on academic success. These two factors, considered together, gave the lowest error value during modeling, which indicates their synergistic role in the learning process. The results confirm that clarity in the transfer of knowledge, combined with the engagement and motivation of teachers, significantly contributes to achieving better educational results for students in general education subjects.

Table 6. The impact of two entrances on the exit for general education subjects in vocational studies

Input no. 1 - 4
TRAINING ERROR SV = -0.000000 SD = 0.089277 MSE= 0.007940 RMSE= 0.089109
TEST ERROR SV = -0.019560 SD = 0.077751 MSE= 0.006299 RMSE= 0.079368
ALL DATA SV = -0.0029468 SD = 0.087802 MSE = 0.0076931 RMSE = 0.08771

Figure 14 provides a representation of errors through all stages of modeling, indicating a satisfactory ability of the model to identify patterns and trends resulting from the interaction of two combined factors, which allows for a deeper understanding of their impact on achievement.

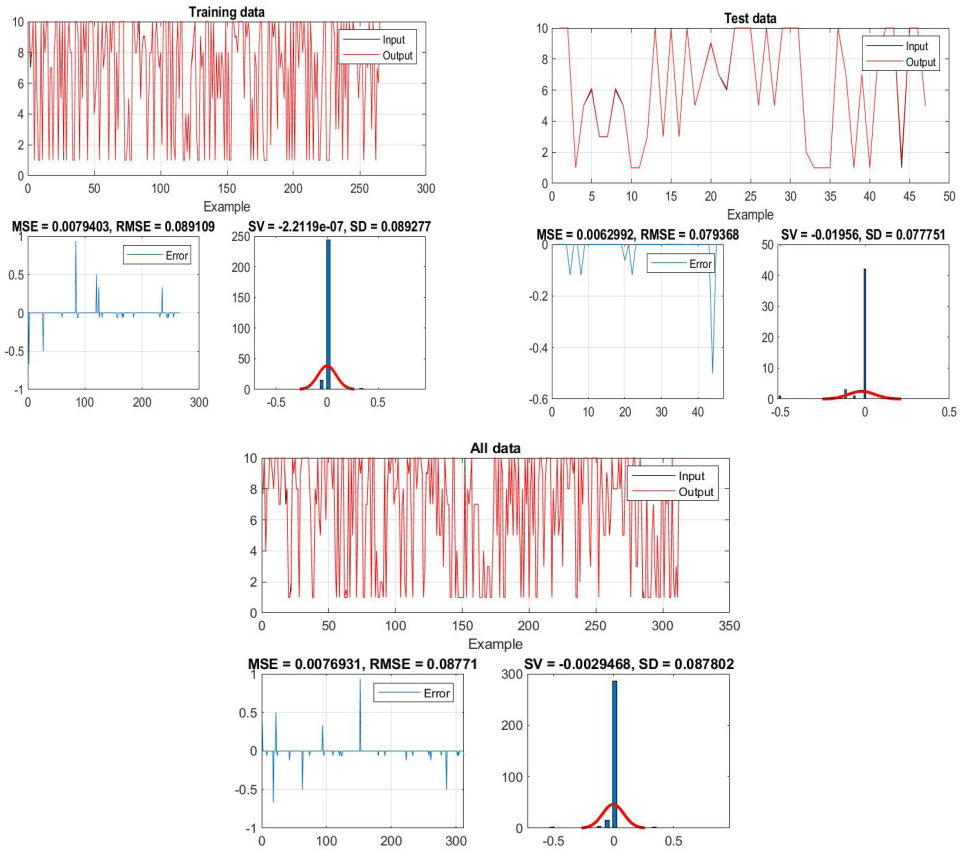


Figure 14. Effect of two inputs on achievement - results of training, testing and aggregate data of the ANFIS network

Figure 15 shows the regression analysis and reliability of the model for the two combined factors, which is important for assessing the accuracy of the predictions. Linear correlation coefficients are R=0.99969 for training, R=0.99977 for test and R=0.9997 for all data. Figure 16 shows a 3D graph illustrating the dependence of motivation on two inputs (input1 and input2), randomly selected to identify the most influential factors. The colors on the graph indicate the levels of motivation: blue - low, green - medium, yellow - high. This visual representation enables the quick identification of areas with different levels of motivation and contributes to a better understanding of the influence of the analyzed factors, in this case inputs 1 and 4.

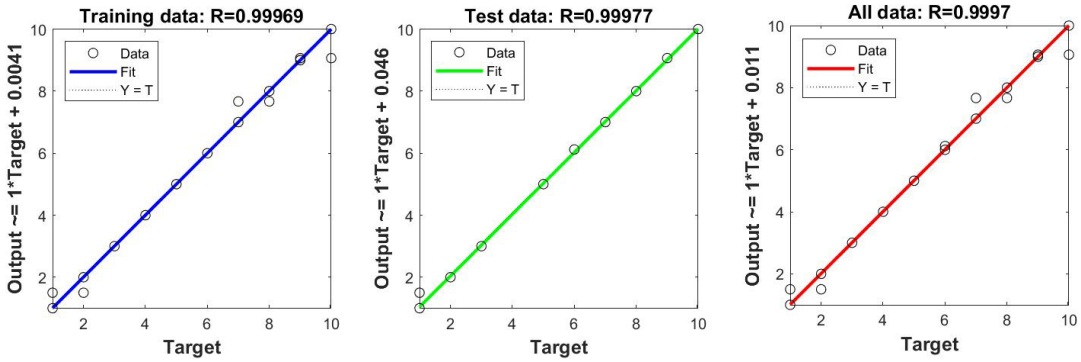


Figure 15. Linear regression of training, test and all data - influence of two inputs

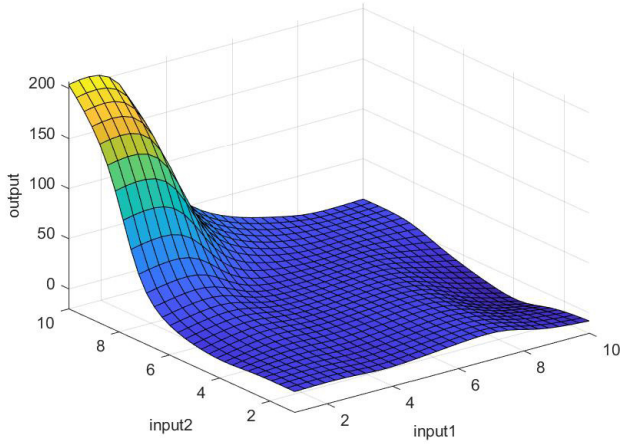


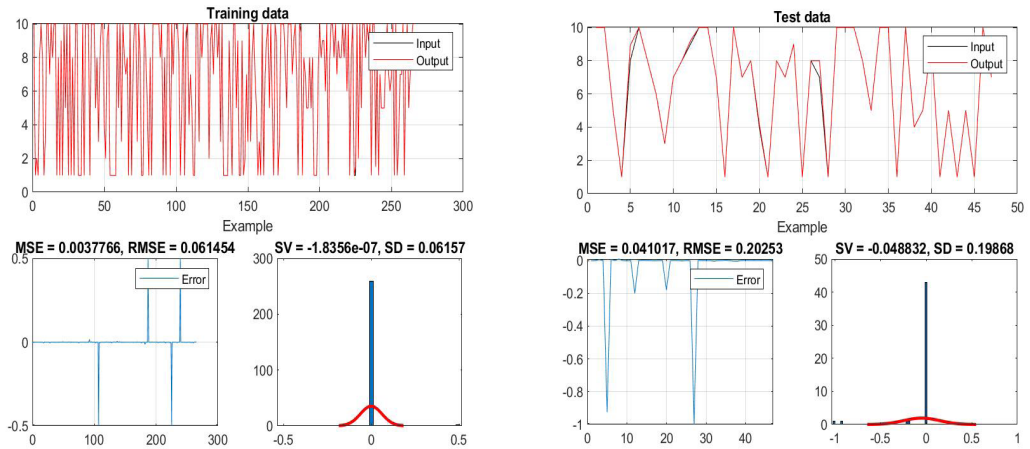
Figure 16. Graphical interpretation of training data - impact of two inputs

When examining the impact of the three combined factors - comprehensibility, applicability and teacher commitment - on student achievement, shown in Table 7, it is noted that these factors together have the smallest model error, which indicates their greatest joint impact on achievement. This combination of factors makes a notable contribution to explaining the variability in student achievement, reaffirming the importance of presentation clarity, the relevance of teaching content, and teacher engagement in the learning process.

Table 7. The impact of three inputs on output for general education subjects in vocational studies

Input no. 1 - 2 - 4
TRAINING ERROR SV = -0.000000 SD = 0.061570 MSE= 0.003777 RMSE= 0.061454
TEST ERROR SV = -0.048832 SD = 0.198678 MSE= 0.041017 RMSE= 0.202528
ALL DATA SV = -0.0073562 SD = 0.09676 MSE = 0.0093866 RMSE = 0.096884

Figure 17 shows the influence of the three combined factors on the accuracy of the model through the analysis of errors during training, testing and on the entire data set. This kind of analysis makes it possible to see how the joint action of these factors affects the precision of predictions and the overall reliability of the model in different phases of work. And with this model, all errors are satisfactory.



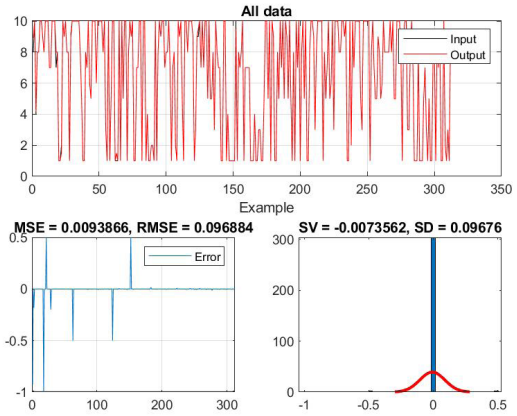


Figure 17. Impact of three inputs on achievement - results of training, testing and overall ANFIS network data

The linear correlation coefficient, Figure 18, for the training set is R=0.99985, for the test set R=0.99822, while for the entire data set it is R=0.99963, which indicates the high accuracy of the model. Figure 19 shows a graphical interpretation of the training data for combinations of inputs 1 and 2, 1 and 4, as well as 2 and 4. The display illustrates how different randomly selected combinations of input parameters affect the output value. The color distribution on the graph indicates the output level – blue for low values, green for medium and yellow for high. This visualization enables the clear recognition of areas with significant output changes, providing insight into the impact of each individual combination of the three most important factors on the final result.

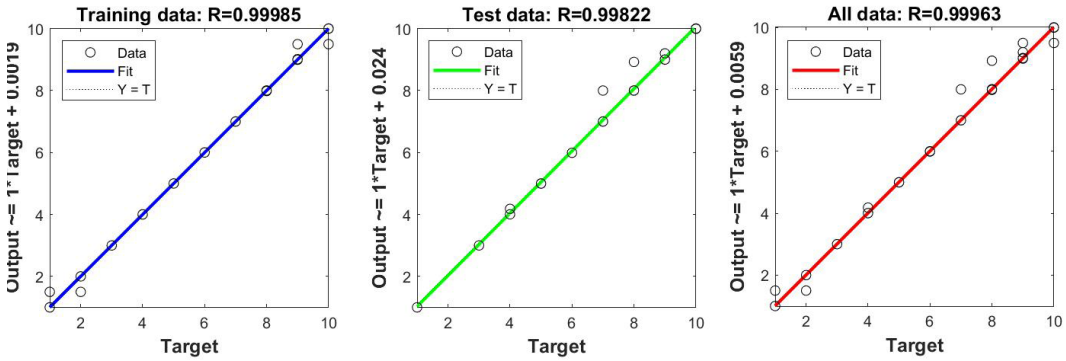
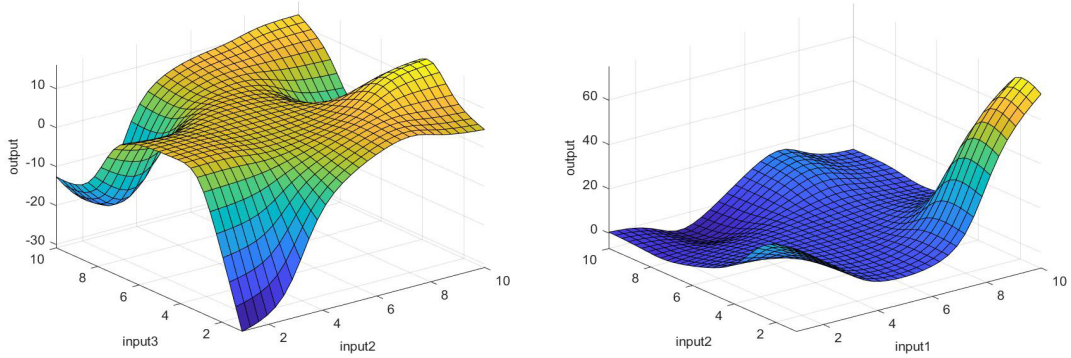


Figure 18. Linear regression of training, test and all data - influence of three inputs



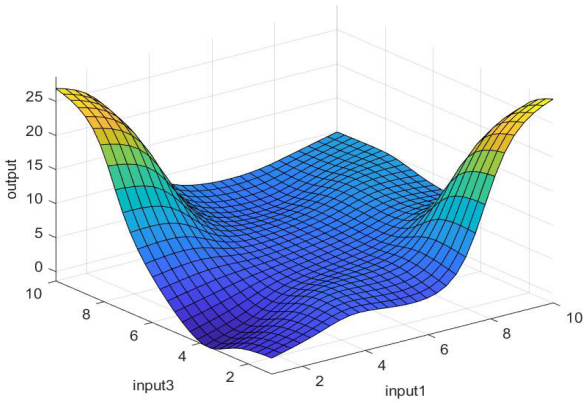


Figure 19. Graphical interpretation of training data - impact of three inputs

Discussions

As part of this research, a comparative analysis of the influence of various factors on the achievement of respondents in vocational studies was carried out, whereby two groups of subjects were observed - professional-applicative and general education. The analysis enabled a deeper insight into the specificities that characterize each of these groups, both in terms of individual factors and their mutual combinations.

In professional-applied subjects, the results showed that the teacher's commitment is the single most important factor that affects the achievement of the examinees. When the combined factors were analyzed, the most pronounced impact was recorded in the combination of the quality of teaching and teaching materials together with the commitment of the teacher, while in the analysis of three factors it was shown that the additional inclusion of the working atmosphere in the class additionally contributes to the accuracy of the prediction and the explanation of the variance in achievements.

On the other hand, the results obtained for general education subjects indicate a somewhat different pattern of influence. At the level of individual factors, comprehensibility of the material stood out as the most influential factor. In the case of the combination of two factors, the greatest impact on the achievement of the respondents was the connection between comprehensibility and commitment of the teacher, while in the model with three combined factors, the most significant effect was achieved by combining comprehensibility, applicability of the material and commitment of the teacher.

Such results indicate that there are specific differences in the factors that contribute the most to academic achievement depending on the type of subject. In vocational and applied subjects, the primary contribution comes from factors associated with the quality of practical teaching implementation and teacher involvement, whereas in general education subjects, the clarity and relevance of the content take precedence, with the teacher's dedication remaining a consistently significant factor.

This analysis confirms that in order to improve the educational process, it is necessary to adapt approaches and work methods to the specifics of each group of subjects, with a special focus on the most influential factors identified by this research. The obtained results can serve as guidelines for the further development of teaching strategies and improvement of the quality of teaching at professional studies.

Conclusions

This research aimed to identify and analyze the key factors that influence the achievement of respondents in vocational studies, through the application of soft computing approaches, specifically the ANFIS model. Through the comparative analysis of two groups of subjects - professional-applicative and general education - significant insights into different patterns of influence of individual and combined factors were obtained.

The results showed that in vocational-applied subjects, the most significant single factor relates to the teacher's commitment, while the most influential combined factors included the quality of teaching, the

quality of teaching materials and the working atmosphere in the class. On the other hand, in the case of general education subjects, the most prominent single factor was the comprehensibility of the material, while in combinations the key influence was the comprehensibility, applicability and dedication of the teacher.

The application of the ANFIS model proved to be an effective method for analyzing the influence of several factors simultaneously, with satisfactory error values and a high degree of accuracy in predicting achievement. This methodology enabled accurate modeling of complex patterns of interdependence between factors and target size.

Bearing in mind the specificity of the identified factors depending on the type of subject, the results of this research can serve as a basis for improving teaching methods and strategies in higher education. By applying the findings in practice, educational institutions can develop targeted interventions aimed at improving key aspects of teaching.

As a direction for future research, it is recommended to expand the sample to other educational levels and different study programs, as well as to include additional factors that could have a significant impact on academic achievements, such as motivation, learning approaches and forms of knowledge evaluation. Also, it would be useful to apply other methods of artificial intelligence and soft computing approaches, in order to additionally check the reliability and generalization of the obtained results. Additional longitudinal research could provide deeper insight into the long-term impact of the identified factors on academic success.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Institutional Review Board Statement

Not applicable.

Author Contributions

Conceptualization, M.M., M.S. and S.P; methodology, M.M., M.S. and S.P; software, S.P. and S.B..; formal analysis, M.M. and M.T.; writing—original draft preparation, M.M. and M.S.; writing—review and editing, S.B. and M.T. All authors have read and agreed to the published version of the manuscript.

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Analysis of Trainee Satisfaction with Mentorship in Early and Preschool Education Using Artificial Neural Networks

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Abstract: Effective mentoring is grounded in reciprocal collaboration between mentors and trainees, where mutual respect and open, reflective dialogue are essential from the very beginning of the internship. The aim of this study was to examine which factors predict trainees' satisfaction with their mentors by applying a predictive model. The sample consisted of 104 trainee preschool teachers from Croatia. To test the model, perceptron artificial neural networks were used (with one hidden layer and four neurons), employing the hyperbolic tangent activation function. The results indicated a low discrepancy between the training and test datasets, high classification accuracy, and balanced TPR and TNR values, with an AUC above 0.95, confirming excellent predictive model accuracy. The analysis further revealed the relative predictive strength of individual factors related to satisfaction with the quality of mentor cooperation. The mentor–trainee relationship emerged as the strongest predictor, while net salary proved to be a more influential predictor of satisfaction with mentor cooperation than support from principals or professional associates.

Keywords: *mentor–trainee relationship, machine learning in education, factors of satisfaction.*

Introduction

Mentorship is a practice in which a more experienced educator, referred to as a mentor, provides support, guidance, advice, and encouragement to a novice or less experienced educator, referred to as a mentee—in this case, a preschool teacher trainee (Bressman et al., 2018). The primary aim of this practice is to improve the overall quality of teaching and learning in preschool institutions. A preschool teacher trainee, without prior professional experience, acquires relevant knowledge and develops professional competencies during a one-year traineeship in preschool institutions, supported by a mentor and the institution.The objectives of preschool teacher traineeship programs include enhancing trainees' competence, quality of practice, motivation, job satisfaction, career opportunities, and fostering personal achievement (Hadley et al., 2024; Ingersoll, 2012). Support provided by mentors, professional staff, and the principal within the preschool institution is positively associated with a smoother and more effective

transition from traineeship to professional teaching, reduced levels of professional burnout, and sustained motivation for educational work (Carmel and Paul, 2015). The content of the traineeship program is designed to equip preschool teacher trainees with the competencies and sense of responsibility required to fulfill their social role within the educational system (Vassileva, 2021). The core tasks of preschool teacher trainees encompass the application of theoretical knowledge in professional practice, the use of diverse pedagogical strategies to foster children's development, the planning and organization of educational activities, and the enhancement of communication skills. These tasks often represent a considerable challenge for novice practitioners (Carmel et al., 2023).

Within this process, collaboration with the mentor, systematic exchange of information, and ongoing evaluation constitute essential dimensions of professional development. In Croatia, the traineeship

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of preschool teachers is implemented in accordance with a program proposed by the traineeship committee and formally approved by the designated professional body of the preschool institution. This committee—composed of the principal, the mentor, and a professional associate—is responsible for program design, provision of professional support to the trainee, and systematic monitoring of their progress. The mentor, who maintains official records of the traineeship, is typically an educator who has successfully passed the state professional examination.The *Regulation on the Procedure, Methods, and Conditions for Career Advancement and the Attainment of Professional Titles of Preschool Teachers, Professional Associates, and Principals in Preschools (NN 133/1997, NN 83/2024)* establishes that educators possessing the required professional qualifications and meeting the prescribed evaluation standards are eligible for career advancement and the attainment of the professional titles of Mentor, Advisor, and Senior Advisor. The evaluation of mentors' expertise and quality of practice is based both on demonstrated effectiveness in educational work and on their continuous engagement in professional learning and development.In the Republic of Croatia, the induction year for preschool teacher trainees lasts for one year, starting from the date of employment. Preschool institutions are required to adopt a formal probationary program within 15 days of employing a trainee, appoint a traineeship committee, and report the induction to the competent authorities. The *Regulation on the Procedures and Conditions for Taking the Professional Examination for Preschool Teachers and Professional Associates in Preschools (NN 133/1997, NN 84/2024)* specifies the mandatory content of the program. In addition, preschool teacher trainees are obliged to participate in structured professional development and to engage in a minimum of 30 hours of mentoring with their assigned mentor.The traineeship committee is required to observe the trainee's professional practice at least twice during the probationary period. Upon completion, the trainee must sit a teacher certification examination, which consists of three components: a written test, an oral examination, and a practical assessment.

Factors Influencing Preschool Teacher Trainees' Satisfaction with the Induction Program

For a successful and effective induction period, as well as for establishing a high-quality mentoring relationship, it is essential to maintain a collaborative relationship with the mentor (Ewing, 2021; Shanks et al., 2020), mutual understanding (Goodwin et al., 2021), acceptance of diverse professional roles, and reciprocal respect (Ambrosetti, 2014; Ingleby, 2014; Kupila et al., 2017). David and Kim (2023) emphasize the importance of transforming mentorship into a democratic process in which both participants respect one another with the aim of achieving positive outcomes. A key characteristic of the mentor–trainee relationship is the establishment of an open, reflective dialogue from the very beginning of the induction period. Izadinia (2016) stresses that a high-quality mentoring process relies on systematic, constructive, and timely feedback, as well as active listening. According to Nesbit et al. (2025), mentorship is based on the premise that trainees improve their practice through everyday interactions with other educators and their mentor, and that professional development linked to the environment in which educators carry out their educational practice leads to sustainable and meaningful change. In this context, the collaborative process between the mentor and the trainee involves three critical steps: *Goal-setting*, including the identification of the necessary steps to achieve those goals;*Targeted observations* of educational practice aligned with the identified goals; and *Provision of feedback* by the mentor and modeling to improve pedagogical practice, complemented by reflective practice. Dreer-Goethe (2023) highlights that the well-being of preschool teacher trainees is closely associated with the quality of mentorship. This connection encompasses the mentor's perception of the mentoring process, their decision to engage in the process, their contribution to the functionality of the mentor–trainee relationship, as well as their choice and application of mentoring styles that support the well-being of both mentor and mentee. Furthermore, the conceptual hypothesis suggests that the quality of mentoring is linked to the well-being of the trainee, which in turn is connected to their professional development. Many of these relationships appear to be reciprocal, implying that mentors' well-being also contributes to the quality of mentorship and to the well-being of the trainees themselves. Findings from Dreer-Goethe (2023) research with mentors and trainees indicate that the well-being of both parties is strongly shaped by the broader context in which the mentoring process takes place.

In a study conducted by Hudson (2013), both mentors and trainees were examined within a mentorship program that focused on relationships, school culture, and infrastructure, as well as on five key factors of mentorship: personal attributes, systemic requirements, pedagogical knowledge, modeling and feedback, and problem-solving and leadership. The findings indicated that material conditions represent-

ed one of the motivating factors for trainees to actively engage in the induction program. Mentors emphasized that their everyday professional experiences were new learning opportunities for trainees, while the trainees expressed overall satisfaction with the mentoring process. The mentors' focus was primarily on lesson planning, instructional preparation, and the development of classroom management strategies, alongside reflections on their personal teaching philosophies and theories of learning. Similarly, Andrews et al. (2024) argue that the primary goal of formal mentorship is to provide sustained support to trainees in their professional development. Their study examined the experiences of 145 preschool teacher trainees during the first five years of their professional careers, supported by 51 experienced mentors. The project began with a mentor training course, and data were collected through pre- and post-mentoring surveys. The results demonstrated that preschool teacher trainees gained a clearer understanding of their professional role, developed stronger collegial relationships with other educators, and that effective mentorship can significantly contribute to addressing the challenges encountered by novice teachers. The study conducted by Ben-Amram and Davidovitch (2024) involved 46 mentors. Their findings indicate that mentors are primarily motivated by a personal mission and an intrinsic desire to provide support to trainees. Achievement of personal values, vision, and the challenges inherent in mentoring were highlighted as significant motivational factors. Mentors made substantial contributions to trainees' planning of educational activities and the development of their professional identity. Similarly, the research by De Ossorno Garcia and Doyle (2021) suggests that, from the perspective of trainees, the psychosocial function represents a critical component of the mentor–trainee relationship. Data analyses indicated that preschool teacher trainees emphasize trust, decision-making, personality, and self-efficacy as key motivational factors. In contrast, mentors tend to focus on career development and the fulfillment of programmatic aspects, including monitoring interaction frequency and transferring professional knowledge to trainees.

Beyond the mentor, the principal plays a pivotal role in developing a shared vision for the institution and empowering staff to achieve set objectives. Active participation of principals in educational practice fosters cohesion among teachers and ensures collegiality, which is essential for the successful implementation of pedagogical activities (Niklasson, 2019; Tynjälä and Heikkinen, 2011). Principals who cultivate positive relationships with staff and create a supportive organizational culture contribute to increased teacher autonomy in the teaching process. Support provided by principals to trainees during the induction year includes ensuring high-quality mentorship. Carver-Thomas and Darling-Hammond (2017) emphasize the importance of securing financial resources to sustain mentorship programs. Structured induction programs that include mentor assignment, regular meetings, observation and feedback sessions, discussion of educational practices, and the development of professional growth plans have been shown to be effective in facilitating mentorship. Findings from Li and Khairani (2025) underline several implications for preschool teacher induction programs. The establishment of strong social support systems within the induction process fosters the development of positive pedagogical beliefs among trainees and reinforces their theoretical pedagogical identity. Mentorship programs, collaborative engagement, and inclusion of all participants in the educational process are highlighted as critical components in the professional development of preschool teacher trainees.

Given that the transition from initial education to professional teaching practice is recognized as a critical period in defining each educator as a professional, this study aimed to explore, through assessments by novice educators, their relationship with mentors, satisfaction with the implementation of the induction program, and perceptions of support provided by principals and professional associates.

Materials and Methods

Research Aim

The aim of the study was to identify predictors of preschool teacher trainees' satisfaction with mentors using *Machine Learning – Perceptron Artificial Neural Networks.*

Sample

The participants consisted of novice preschool teachers **(**n = 104**)** from Croatia. To obtain a comprehensive understanding of the research topic, the study included educators with up to seven years of

professional experience, as they were considered capable of reliably evaluating their induction experiences.The age distribution of participants was as follows: 41 participants were under 25 years of age, 49 participants were aged 26–35, 12 participants were aged 36–44, and 2 participants were aged 45–55. Regarding professional experience, participants were included if they had completed their traineeship within the past seven years. The distribution of participants according to years of service was as follows: 41 participants had up to 2 years of experience, 32 participants had 3–4 years of experience, and 31 participants had 5–7 years of experience.

Data Collection Method

Data were collected using the *Mentor Relationship Assessment Scale* (Vizek Vidović, 2011), which consists of 18 items. Two additional subscales were constructed: *Principal Support and Professional Associates' Support***.** The *Principal Support* subscale included the following items:v19: *During my induction year, I received support and assistance from the principal.v22: The principal treated me as an equal partner during my induction year.v23: The principal showed interest in my professional development during the induction year.v25: The principal monitored and supported all activities in the preschool during my induction year. v27: The principal was sensitive to my needs and those of other staff members during my induction year. v29: The principal provided support and assistance to my mentor during my induction year.* The *Professional Associates' Support* subscale included the following items: *v20: During my induction year, I received support and assistance from professional associates. v21: Professional associates treated me as an equal partner during my induction year. v24: Professional associates showed interest in my professional development during the induction year. v26: Professional associates monitored and supported all activities in the preschool during my induction year. v28: Professional associates were sensitive to my needs and those of other staff members during my induction year. v30: Professional associates provided support and assistance to my mentor during my induction year.* Participants indicated their level of agreement on *a 3-point Likert scale*, with the following response options: 1 = Strongly disagree, 2 = Partially agree, and 3 = Strongly agree. At the end of the questionnaire, participants were also asked to evaluate their overall satisfaction with the quality of collaboration with their mentor, using a 3-point scale (1 = dissatisfied, 2 = satisfied, 3 = very satisfied). Data were collected via a *Google Docs form* between June and September 2024. The questionnaire link was distributed through principals, professional associates, and Preschool Teachers' Associations in Croatia, who then forwarded it to the educators. Participation was anonymous, and respondents were informed that they could withdraw from the survey at any time.

Results

Three composite predictor variables were constructed (Table 1).

Table 1. *Descriptive Statistics of Composite Variables*

	Min	Max	Mean		Mode	Med	Std. Dev.	Skewness		Kurtosis	
	Stat	Stat	Stat	Std. Error			Stat	Stat	Std. Error	Stat	Std. Error
Mentor Relationship (KOMP1)	1,0	3,0	2,45	,064	3	2,83	,660	-,954	,237	-,533	,469
Professional Associates' Support (KOMP2)	1,0	3,0	2,20	,064	3	2,33	,655	-,461	,237	-1,01	,469
Principal Support (KOMP3)	1,0	3,0	2,24	,068	3	2,50	,699	-,493	,237	-1,22	,469

All composite variables were measured on a 3-point Likert scale, with the following response options: 1 = Strongly disagree, 2 = Partially agree, and 3 = Strongly agree. As indicated, the composite variables exhibit high mean values, low standard errors, left-skewed (negatively skewed), and slightly platykurtic distributions. The dependent variable, *Overall, how satisfied are you with the quality of collaboration with your mentor?*, was also measured on a 3-point scale (1 = dissatisfied, 2 = satisfied, 3 = very satisfied). Descriptive statistics for the dependent variable are as follows: range = 2, mean = 2.55, standard error of the mean = 0.069, SD = 0.708, skewness = -1.295, kurtosis = 0.233. These distributions suggest that participants generally reported high satisfaction with mentor collaboration, with responses tending toward

the upper end of the scale. To assess the significance of the model, Machine Learning using a *Perceptron Artificial Neural Network (ANN)* was employed. The model consisted of three layers: one input layer, one hidden layer with 4 neurons (nodes), and one output layer with +2 bias units. The Perceptron ANN is a complex, non-parametric mathematical model designed to mimic the functioning of neurons in the brain. It identifies complex relationships among sets of variables and functions as a predictive model based on a loss function. A hyperbolic tangent (tanh) activation function was used (Figure 1). The primary goal was to test the predictive model, specifically the role of predictors on overall satisfaction with mentor collaboration. Initially, independent variables such as gender, age, years of service, preschool size, and professional development were included; however, the model performance was suboptimal. Consequently, these variables were excluded, and the final model incorporated salary (≤1000€: 35 participants, 33.7%; 1001–1200€: 40 participants, 38.5%; 1201–1500€: 26 participants, 25%; 1501–1800€: 3 participants, 2.9%) along with three composite variables: Mentor Relationship (KOMP1), Professional Associates' Support (KOMP2), and Principal Support (KOMP3).

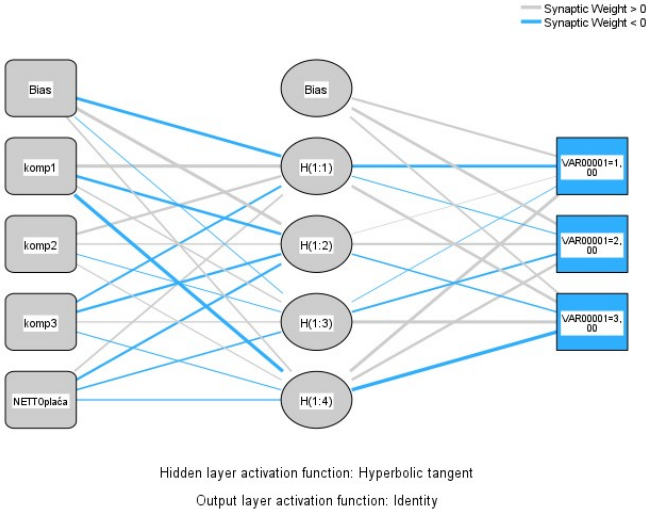

Figure 1. Three-layer model with 4 neurons (nodes) in the hidden layer

Figure 1 illustrates the predictive model with one hidden layer. A model with two hidden layers (deep learning) was also tested, but no significant improvement was observed compared to the single hidden layer model shown in Figure 1. The dataset was split into 74% training data (n = 77) and 26% testing data (n = 27). Figures 2 and 3 graphically display the activation function values for each input and hidden layer neuron (H1:1, H1:2, H1:3, H1:4) as well as the output layer. The same data split of 74% training and 26% testing was applied in these analyses.

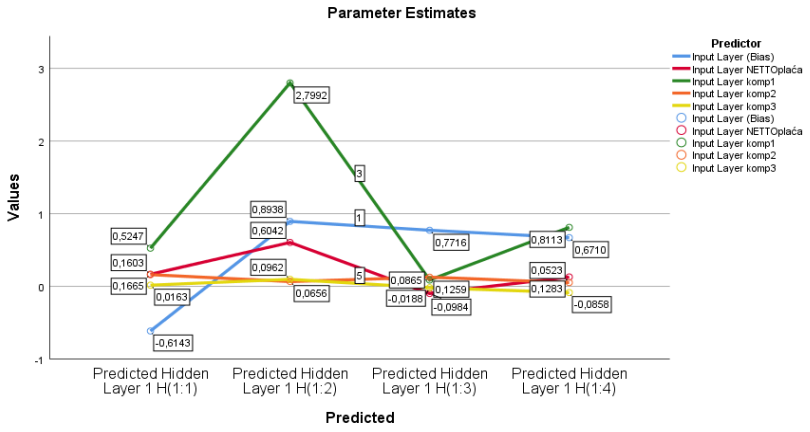

Figure 2. Graphical representation of the activation function for the input i hidden layer H(1:1), H(1:2), H(1:3), H(1;4)

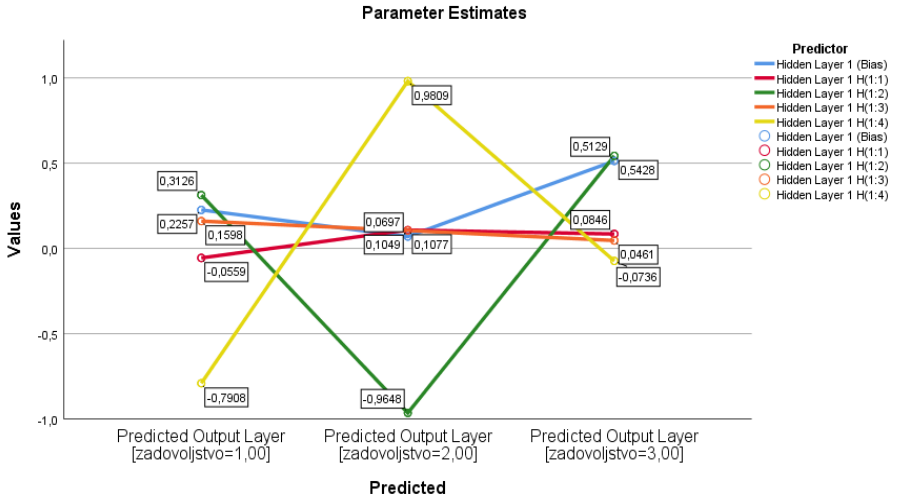

Figure 3. Graphical representation of the activation function values for the output layer and the hidden layers H(1:1), H(1:2), H(1:3), and H(1:4).

Table 2 presents the model summary, that is, the accuracy of the predictive model for both the testing and training samples.

Table 2. *Model summary*

Training	Sum of Squares Error	4,950
	Percent Incorrect Predictions	7,5%
	Stopping Rule Used	1 consecutive step(s) with no decrease in error[a]
	Training Time	0:00:00,01
Testing	Sum of Squares Error	1,562
	Percent Incorrect Predictions	8,3%

Dependent Variable: Satisfaction with the Quality of Collaboration with the Mentor

a. Error computations are based on the testing sample.

Table 2 shows that the prediction accuracy in the training sample is 92.5%, compared to 91.7% in the testing sample. The minimal discrepancy between the models indicates a high predictive validity regarding satisfaction with the quality of mentor collaboration. Classification accuracy is provided in Table 3.

Table 3. *Classification*

		Predicted			
Sample	Observed	1,00	2,00	3,00	Percent Correct
Training	1,00	5	2	0	71,4%
	2,00	2	15	0	88,2%
	3,00	0	1	51	98,1%
	Overall Percent	9,2%	23,7%	67,1%	93,4%
Testing	1,00	4	2	0	66,7%
	2,00	0	3	0	100,0%
	3,00	0	0	19	100,0%
	Overall Percent	14,3%	17,9%	67,9%	92,9%

Dependent Variable: Satisfaction with the Quality of Collaboration with the Mentor

In the training sample, among those who completely agree (3), 51 were correctly classified, corresponding to a prediction accuracy of 98.1%. Only 1.9% of the responses in this category were misclassified as “partially agree,” representing the error rate. When examining all prediction errors across both the training and testing samples, accuracy levels range between 66.6% and 100%. Lower accuracy is observed in the testing sample within the category “strongly disagree.” The graphical representation of model accuracy is provided in Figure 4.

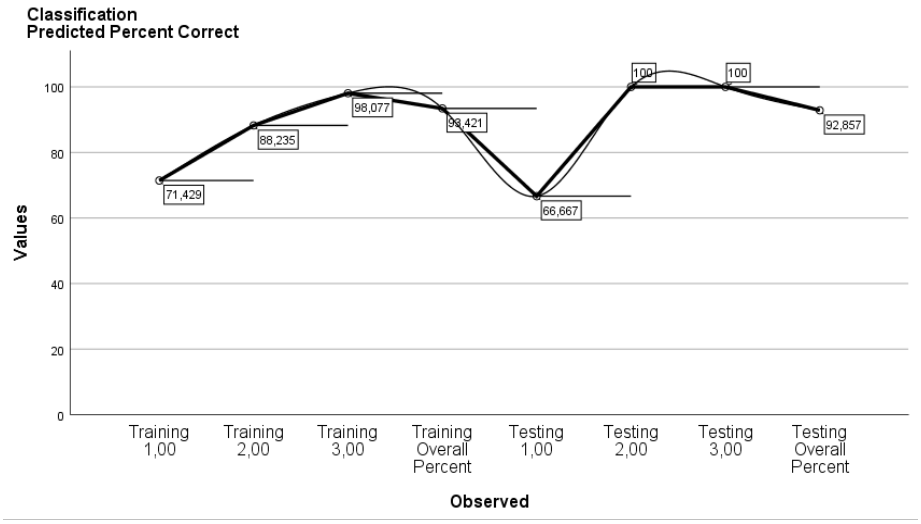

Figure 4. Accuracy of the predictive model

The area under the curve (AUC) for the dependent variable categories is 1 (0.963), 2 (0.970), and 3 (0.997), indicating an excellent balance between true positive rate (TPR) and true negative rate (TNR), i.e., between specificity and sensitivity. This means the model accurately identifies both correct positive and correct negative responses, with a low number of false positives (FP) and false negatives (FN). Additionally, Figure 5 presents the Gain*percentage graph, showing the proportion of each dependent variable category relative to the highest predictive accuracy in the data. Considerable discrepancies are observed: for category 3, 30% of positive cases are captured within the top 20% of results; for category 2, 80% of positive cases are captured; and for category 1, 92% of positive cases are captured.

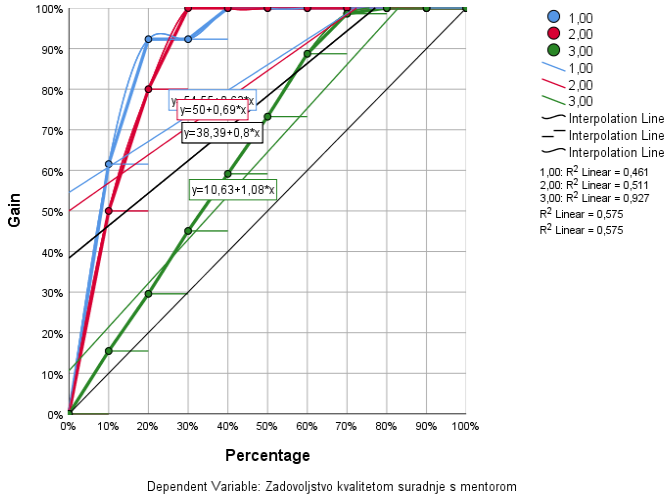

Figure 5. Gain * percentage

Figure 5 illustrates the relative predictive importance of each individual variable with respect to Satisfaction with the Quality of Collaboration with the Mentor**.** The results indicate that the mentor relationship (KOMP 1) is the strongest predictor, while salary emerges as a more significant predictor of satisfaction than support from the principal or professional colleagues. This finding can be explained by the fact that salary reflects both an existential need and a status indicator within the profession. Consequently, it is unsurprising that salary exerts a greater influence on perceived satisfaction with mentor collaboration than support from the principal or professional colleagues.

Discussions

Novice educators need support during their entry into the profession. The quality of their professional development and future work will depend on whether they received support during their induction period. This study aimed to identify predictors of novice educators' satisfaction in relation to their mentors. The results of the relative predictive importance of each individual variable on the value of *Satisfaction with the Quality of Collaboration with the Mentor* indicate that the relationship with the mentor (KOMP1) is the most significant predictor, while salary is a more important predictor of satisfaction than support from professional colleagues (KOMP2) and support from the principal (KOMP3). Support during the induction period is crucial for guiding novices into the profession. Most novices in the study by Mokoena and van Tonder (2024) faced significant challenges during their professional entry due to the absence of mentor support. Poor guidance of novices, ineffective communication, and lack of principal support were identified as key sources of dissatisfaction in the study by Louws et al. (2017). Thornton (2024), who examined mentors' readiness for mentoring processes, found that many mentors working in educational contexts are insufficiently prepared for this role and suggests participation in programs that would prepare mentors for this process. The author believes that mentors could strengthen their knowledge during such programs and learn various strategies and methods for working with novice educators. In our study, participants rated principal support relatively high (M = 2.24; SD = 0.699), support from professional colleagues slightly lower (M = 2.20; SD = 0.655), while the mentor relationship received the highest rating (M = 2.45; SD = 0.660). Consistent with the findings of Schuck et al. (2018), a high level of mentor support facilitates coping with the challenges inherent in the profession.

Walker and Kutsyuruba (2019) argue that encouraging novice educators to independently carry out tasks contributes to the development of self-efficacy, confidence, autonomy, and professional identity. Erawan (2019) warns that many novice educators leave the profession due to a lack of professional support, frequently facing behavioral challenges in children that they do not know how to manage, coupled with high workloads. Federičová (2021) emphasizes that approximately 45% of beginning teachers in European countries leave the profession entirely within five years of employment. Similarly, Ingersoll (2012) confirms that negative experiences during induction can lead to professional attrition, noting that 50% of novices exit the profession within five years if early experiences are negative. Considering these findings, our study included novice educators with work experience ranging from the first to the seventh year, confirming that satisfaction derived from the mentor relationship during the induction period positively influences later perceptions and overall job satisfaction. The effectiveness and quality of professional entry, induction, and subsequent work also depend on the characteristics of the novice educator. To successfully develop practical experience, a novice must demonstrate high motivation, enthusiasm, and a desire for learning, empathy and sensitivity in interactions with children, openness to constructive dialogue, flexibility in taking on various tasks, roles, and changes in the work environment, as well as responsibility, reliability, and willingness to engage in teamwork and collaboration.

Accordingly, the first years in the profession are crucial for novice educators to define themselves as professionals and continue their developmental trajectory with motivation. Otherwise, they may leave the profession, perpetuating the concerning trend that has become increasingly prevalent in recent years. Furthermore, our results indicate that the mentor relationship is the most significant predictor of novice educators' overall satisfaction with the quality of collaboration with their mentor, whereas salary is a more important predictor than support from the principal or professional colleagues. In line with this, Darling-Hammond (2021) emphasizes that educational systems aiming to meet the demands of 21st-century teaching must not only recruit the best novices but also guarantee working conditions comparable to those of established professionals. This approach establishes professional norms that ensure status, salary, professional autonomy, and accountability. Motivation for entering the profession is often a combination of status, work environment, sense of personal contribution, and financial rewards (OECD, 2005). Research by Farinde-Wu and Fitchett (2018) shows that job satisfaction correlates with teacher retention, which, in turn, positively affects the overall climate of the institution. Based on these findings, the authors conclude that job satisfaction can reduce teacher attrition. The mentoring process significantly shapes the professional development of novice educators and their perception of the profession, which consequently influences the formation of the professional culture within the institution.

Conclusions

Professional development of educators begins with initial education and continues with entry into the profession; therefore, the induction period is considered the most critical phase for guiding and retaining novices in the field. The mentor plays a pivotal role in shaping the professional identity of novice educators, making support within this relationship essential to ensure that novices receive timely information and assistance. Early childhood education practice is complex and dynamic, requiring well-prepared educators who have the knowledge, skills, and motivation to manage the challenges it presents. Trust, mutual respect, and regular communication are thus indispensable elements of effective mentoring relationships. The synergy between mentor and novice creates a stimulating environment for learning and development, directly influencing the ongoing growth of both the novice and the mentor. Conversely, the absence of support often results in novices leaving the profession, which, particularly in the current context, negatively impacts the quality of early childhood education institutions.

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Conflict of interests

The Authors declares that there is no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

For more information in this regard, please see: https://www.ijcrsee.com/index.php/ijcrsee/journal_policies

Institutional Review Board Statement

Prior to participation, informed consent was obtained from all participants. Participants were informed of the study's objectives, procedures, potential risks, and benefits, as well as their right to withdraw at any stage without any negative consequences.

All ethical considerations were observed, including the confidentiality of personal information, voluntary participation, and data protection in accordance with applicable legal and institutional guidelines.

Author Contributions

Conceptualization, T.K., A.V.; methodology, S.O.; software, S.O.; formal analysis, S.O.; writing—original draft preparation, T.K., A.V. and S.O.; writing—review and editing, T.K., A.V. and S.O. All authors have read and agreed to the published version of the manuscript.

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From Awareness to Action: Preparedness of SMEs for Artificial Intelligence Implementation in North Macedonia and Serbia

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Abstract: Artificial Intelligence (AI) is growingly recognized as a critical factor in fostering innovation and strengthening competitiveness within contemporary enterprises. As regards digital transformation, AI technologies are reshaping traditional operating models and enabling the optimization of core operating processes across various sectors. Small and medium-sized enterprises (SMEs) in the Republic of North Macedonia and the Republic of Serbia despite being key drivers of economic activity and employment, encounter considerable challenges in integrating AI into their daily operations, in contrast to larger enterprises that typically possess greater resources and structural capacities for technological adoption. The focus of the paper is to assess the level of awareness, viewpoints, and preparedness of entrepreneurs from both countries regarding the implementation of AI within their business strategies. Accordingly, the research examines the main sources of information available to SMEs, the extent to which planning processes incorporate AI adoption, the perceived limitations and associated risks, as well as the need for adequate professional expertise and institutional support to advance digital transformation.

Keywords: *artificial intelligence (AI), digital transformation, small and medium-sized enterprises (SMEs), business policy.*

Introduction

During the digitalization age, artificial intelligence (AI) is gaining prominence as a transformative force within contemporary business environments. It is instrumental in redefining operational models and enabling comprehensive improvements in organizational performance. Increasingly recognized as a significant driver of innovation and market competitiveness, the integration of artificial intelligence (AI) spans multiple business domains, enabling the automation of routine activities, efficient data processing, market trend prediction, and more informed strategic planning. Artificial intelligence offers a several advantages over information based on financial statement analysis (Mitrović et al., 2025).

Regarding digital change, it is very important to have collaboration among enterprises, policymakers, and researchers in facing the challenges and risks of information transformation, as well as ascertaining that its benefits are distributed equally among all stakeholders. This necessitates a collaborative and multidisciplinary strategy that includes the creation of new rules, regulations, and frameworks to enable the digital transformation of enterprises and communities (George, 2024). The European Commission, in April 2021, proposed the EU's inaugural artificial intelligence (AI) legislation, which outlined a classification system based on levels of risk. Artificial intelligence technologies applicable to various domains are systematically analysed and classified in accordance with their potential risk to users. The different risk degrees mean more or less artificial intelligence (AI) compliance requirements (European Parliament, 2023).

Artificial intelligence (AI) has been gaining an increasingly integral role of business operations, with its growing application over recent years thoroughly remodelling industrial landscapes across the globe.

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The opportunity to apply artificial intelligence (AI) as an operating tool to improve business policy development remains largely obscure in countries such as Macedonia and Serbia. The potential of artificial intelligence (AI) is recognized in enterprises in these regions as a significant tool in creating policies that align with dynamic market conditions, optimizing operational efficiency, and predicting future trends. Nevertheless, the degree to which AI is affecting policymaking in these enterprises and the challenges they face in adopting it remains poorly understood. Therefore, this paper explores how artificial intelligence (AI) technologies are remodelling business policy making with regards to Macedonia and Serbia. The paper's objective is examining the use of artificial intelligence (AI) in policymaking, assessing its practical consequences, and proposing actionable recommendations for enterprises seeking to utilize artificial intelligence (AI) technologies in pursuit of sustainable development. Recently, the implementation of artificial intelligence (AI) technologies has accelerated notably in operating activities, leading to the transformation of industries on a global scale. Despite this global trend, in countries as Macedonia and Serbia the strategic use of AI for business policy development remains relatively limited and insufficiently investigated. artificial intelligence (AI) though the enterprises in these regions greatly acknowledge the AI potential to enhance policy formulation by aligning strategies with rapidly changing market conditions, improving operational performance, and enabling more accurate forecasting the practical application and depth of its influence remain underexplored. Based on data analysis and strategic planning for the long term, there is a developing recognition of AI's capacity to support decisions. However, many enterprises continue to face significant limitations to adoption, including limited expertise, infrastructure, and institutional support. Thus, this paper seeks to investigate the role of artificial intelligence (AI) in shaping business policy making within the specific socio-economic contexts of Macedonia and Serbia considering the aforementioned challenges. It aims to analyse both the practical implications of artificial intelligence (AI) adoption and the current level of integration, while offering evidence-based recommendations for enterprises aiming to harness artificial intelligence (AI) technologies as a means of fostering innovation, resilience, and sustainable development. The objective of this paper is to assess the perceptions and preparedness of SMEs in the Macedonia and Serbia regarding the adoption and integration of artificial intelligence (AI) within their operating strategies. The research puts special emphasis on assessing the level of awareness among SMEs concerning the potential benefits of artificial intelligence (AI), identifying key sources of information, evaluating the extent of artificial intelligence (AI) implementation strategic planning, and exploring the primary barriers that hinder adoption. Furthermore, the paper investigates the growing need for professional guidance and focuses on the role played by public institutions in promoting digitalization among SMEs.

In countries such as the Republic of Serbia and North Macedonia, the readiness of small and medium-sized enterprises (SMEs) to implement artificial intelligence (AI) is still insufficiently explored. Both countries are in the process of institutional alignment with European standards: Serbia is already implementing its second Artificial Intelligence Development Strategy for the period 2025–2030, while North Macedonia is developing a national ICT strategy that includes a component for the improvement and integration of artificial intelligence (AI). The Republic of Serbia and North Macedonia were selected for analysis due to their similar economic and institutional characteristics, such as the level of development and the process of European integration.

Given the transformative potential of artificial intelligence (AI) in improving operational efficiency, productivity, and long-term sustainability, addressing these dimensions is essential for developing effective support frameworks and facilitating meaningful artificial intelligence (AI) adoption among SMEs. To guide the research process, the paper outlines five key research questions:

1. To what extent do SMEs believe that artificial intelligence (AI) can enhance business efficiency and contribute to growth and sustainability in the Republic of North Macedonia and the Republic of Serbia?
2. Are there significant variations in the degree of awareness about the possibilities of applying artificial intelligence (AI) between enterprises in the Republic of North Macedonia and the Republic of Serbia?
3. How does the number of years an enterprise has been operating affect its level of awareness about AI applications and its perception of the need for implementation?
4. Does the business sector influence the perception of artificial intelligence (AI) contribution to the growth and sustainability of enterprises?

5. Are there differences in the perception of the need for organizational changes to implement artificial intelligence (AI) depending on the country of origin, age, and sector of the enterprise?

Materials and Methods

The development of digital technologies is contributing to artificial intelligence being central to the work of enterprises, introducing fundamental changes in the way SME traditionally work. The Organization for Economic Co-operation and Development (OECD) provides a widely recognized definition of an AI system as a "machine-based system capable of making predictions, recommendations, or decisions that affect real or virtual environments, based on a set of objectives defined by humans." (OECD, 2019, 7). According to the Chen et al. (2023), AI systems lack inherent understanding and rely on human decisions in design, engineering, and supervision. With varying degrees of adaptability and autonomy in its application, artificial intelligence brings revolutionary changes to the functioning of the economy and society (Strategija razvoja veštačke inteligencije u Republici Srbiji za period 2025–2030 godine (Službeni glasnik RS, br. 5/25. (2025)). Continuous learning can be specified as a requisite for AI (Samoili et al., 2021). The AI's effects will likely differ widely across different occupations, depending on whether substitution or complementariness between AI and human labour dominate, and to what degree occupations can be reorganized to incorporate new tasks (Fossen et al., 2024). Speculated by Chalmers et al. (2021) is that AI technologies might enable some operation with high technological skills and venture capital firms to gain large financial returns with comparably little effort. This cutting-edge technology promises to fundamentally transform service delivery paradigms, optimize operational processes, and significantly improve efficiency across various industries (Jeremić and Luka, 2024). AI can serve as a new form of input and process other inputs, remodelling the cost structure of a company (Desai, 2019).

Small and medium-sized enterprises (SMEs) have been the focus of extensive research. Wahyuningsih et al. (2024) examined the impact of factors such as education, enterprise size, business duration, accounting training, and accounting knowledge on the utilization of accounting information within SMEs. Mitrović et al. (2024) have conducted research whose approach involves a comprehensive literature review of AIS and organizational performance, along with an examination of the pandemic's effects on both aspects within SMEs. The study findings demonstrate specific consequences of the pandemic on AIS and organizational performance. An important question arises to consider SME and AI through different issues. SMEs in the regions of North Macedonia and Serbia, often face constraints that hinder their access to these technologies, in contrast to large companies that already invest significant resources in the process of developing and applying AI technologies. Moreover, the current solutions offered for digitalization of SMEs are standalone and not incorporated, due to their specific requirements (Telukdarie et al., 2023).

Data shows that in Serbia the significance of digital transformation is acknowledged across all industries and levels of work and is mostly viewed as a prospect that transforms companies to a large extent (Savic et al., 2019). Acord the second Strategy for the Development of Artificial Intelligence (AI) in Serbia for the period 2025-2030 has already been adopted. The previous strategy for the period 2020-2025 laid the foundations and paved the way for the development of AI in Serbia in several key and priority areas, while the current strategy creates the framework for the further development of AI, enabling Serbia to follow modern trends in this area. One of the fundamental aims of the Strategy is to provide a significant incentive for the further development of scientific research, innovation, education, business promotion, economic growth and improve the quality of life of all citizens through special measures (Strategija razvoja veštačke inteligencije u Republici Srbiji za period 2025–2030 godine (Službeni glasnik RS, br. 5/25. (2025)). Serbia has launched the first National AI Platform in the Republic of Serbia at the State Data Centre in Kragujevac, and with the launch of that platform, it has joined the 26 countries that have a national platform for the development of artificial intelligence and is one of the few that have their own Institute for Artificial Intelligence (21 TV, 2025). The Office for IT and e-Government of Serbia and the French company Eviden signed an agreement for HPC (supercomputer) and artificial intelligence development, the project for the digitalization of medical administration, as well as the AI development and application tools that should assist Serbia to flourish in various sectors, from energy, transport and the smart cities' development (Serbia Business, 2025). In addition to providing appropriate infrastructure for the intensive development of the IT market, start-up scene, and venture capital, the country aims to make Kragujevac

a regional centre of modern technology (Bloomberg Adria, 2025).

In North Macedonia, as a result of the global trends in digitalization, at the initiative of the Fund for Innovation and Technological Development, in September 2021 a working group, was formed whose goal is to create the first National Strategy for Artificial Intelligence in the country (FITD, 2021). In North Macedonia, the National ICT Strategy is currently being developed, where in the priority area 'Business, Innovation and New Technologies', a component for the development of AI with an action plan is envisaged. The action plan will determine whether it is necessary to adopt a separate AI strategy or a dynamic roadmap for the promotion and encouragement of the use of AI-based tools. Also, the Ministry of Digital Transformation of North Macedonia, for the second half of 2025, envisages the transposition of the EU AI Act in a form that will encourage the integration and enhancement of AI in the Macedonian ICT ecosystem (Bloomberg Adria, 2025).

Two surveys were conducted using the survey method in the period from February to August 2025. The sample for both *Research 1* and *Research 2* consisted of 100 respondents, surveyed by a random sample, employees and enterprises in North Macedonia and the Republic of Serbia. The research included employees in micro and small and medium enterprises (SMEs*). Research 1* consists of 15 questions, *Research 2* of 20 questions, and the first 3 questions in both surveys refer to data on respondents. *Research 1* refers to the impact of AI on SMEs, while *Research 2* deals with the impact of AI in creating business policies of SMEs. Respondents' views were evaluated on a Likert scale from 1 to 5. Grade 1 signified the least agreement, whereas grade 5 signified the greatest agreement.

Table 1 shows comparative data on the samples. An equal number of respondents come from North Macedonia and the Republic of Serbia (*Research 1* and *Research 2*). In the selected sample structure, the largest number of survey respondents work in an enterprise that has been operating for 6-10 years (44%-*Research 1* and 36%-*Research 2*), which operates in the Services sector (40%-*Research 1*and 32%-*Research 2*).

Table 1. Data on respondents (*Research 1 and Research 2*)

	Research 1		Research 2	
	Number of respondents	%	Number of respondents	%
Where does your enterprise operate?				
North Macedonia	50	50%	50	50%
Serbia	50	50%	50	50%
How long has your enterprise been actively operating?				
1 – 5 years	20	20.0%	29	29.0%
6 – 10 years	44	44.0%	36	36.0%
11 – 20 years	24	24.0%	20	20.0%
More than 20 years	12	12.0%	15	15.0%
In which industry or sector is your enterprise actively working?				
Trade	19	19.0%	17	17.0%
Manufacturing	13	13.0%	22	22.0%
Services	40	40.0%	32	32.0%
IT and Technology	6	6.0%	9	9.0%
Agriculture	3	3.0%	1	1.0%
Construction	11	11.0%	12	12.0%
Education	8	8.0%	7	7.0%

Source: Authors

In addition to descriptive statistical analyses, including mean, standard deviation, minimum, and maximum values, this paper employed the Mann-Whitney U test and the Kruskal-Wallis test. The SPSS version 23 statistical package for social sciences was used with a statistical significance of 0.05 for the purposes of statistical data processing.

Results and Discussions

The statements' frequency about the impact of AI on SMEs is shown in Table 2. The respondents expressed the highest degree of accordance when answering the question - do you think that the introduction of AI will contribute to accelerated growth and sustainability of your enterprise in the future (Mean=3.97). His is supported by Goralski and Tan (2020), who argue that artificial intelligence can serve as a powerful driver of global efforts to foster economic development while ensuring its sustainable management. The respondents expressed the lowest level of agreement in their answers to the question - do you think you have enough knowledge to practice AI in your enterprise (Mean=2.52). Bharadiya's (2023) study revealed several aspects regarding the integration and use of artificial intelligence in enterprises. This study confirms that limited in-depth knowledge about artificial intelligence and its value creation processes represents a significant barrier.

Table 2. *Respondents' views on the impact of AI on SMEs (Research 1)*

Questions	Min	Max	M	SD
Are you familiar with the opportunities offered by AI for improving business activities?	1	5	3.11	1.27837
Do you plan to apply AI in your enterprise?	1	5	3.65	1.12254
Are you sufficiently informed to decide to introduce AI in your enterprise?	1	5	3.33	1.045
How informed are you about the opportunities offered by artificial intelligence for optimizing business processes?	2	5	2.99	1.05883
Do you think you have enough knowledge to practice AI in your enterprise?	1	5	2.52	1.0491
Do you think you will need professional help and support to acquire knowledge about AI?	1	5	3.83	1.08297
Do you think there is sufficient support from state institutions for entrepreneurs to implement AI?	1	5	2.72	1.46391
Is there interest in being involved in support programs for implementing AI if they are introduced?	1	5	3.79	1.2415
Do you think that the introduction of AI will contribute to accelerated growth and sustainability of your enterprise in the future?	1	5	3.97	1.03918

Note: Min (Minimum), Max (Maximum), M (Mean), SD (Standard Deviation)

Source: Authors

The statements' frequency about the impact of AI in creating operating policies of SMEs is shown in Table 3. The respondents expressed the highest degree of agreement when answering the question - do you think that the application of AI will have a positive impact on increasing the efficiency of the enterprise's work (Mean=4.17).

The findings presented above are in accordance with the study by Hamada et al. (2021), investigating the AI use of to improve operating efficiency and effectiveness in companies in Kazakhstan. Their research identified the main obstacle to AI adoption as the hesitance of managers in SMEs to implement AI technologies, further exacerbated by the significant costs involved in their deployment. The respondents indicated minimal agreement regarding the answer to the question - are you familiar with the opportunities offered by AI in creating business policies (Mean=2.69). According to Lauterbach (2019), a significant gap persists in the transparency surrounding the identification of key risks associated with AI, as well as in clarifying the regulatory strategies for mitigating them. Moreover, the absence of a comprehensive, collaborative framework encompassing all relevant stakeholders hinders the establishment of unified principles for the design, governance, and ethical deployment of AI technologies.

Table 3. *Respondents' views on the impact of AI in creating business policies of SMEs (Research 2)*

Questions	Min	Max	M	SD
Are you familiar with the opportunities offered by AI in creating business policies?	1	5	2.69	1.16076
What is the impact of AI in creating business policies?	1	5	3.08	1.27667
Are you sufficiently informed to decide on implementing AI in shaping business policies in your enterprise?	1	5	3.4	0.99494
What are the capabilities of your employees for applying for AI?	1	5	2.76	1.07422
Would you agree to participate in training for using AI tools and technologies?	1	5	4.01	1.16771
Are changes needed in your enterprise to implement AI?	1	5	4.06	1.26187
Do you think there is a need for the reorganization of teams or work structures to enable the adoption of AI in shaping business policies?	1	5	4.04	1.3478
Does your enterprise plan to increase the use of AI in the future?	1	5	3.75	1.08595
Do you think that AI will have a greater impact on business policies in the next 5 years?	1	5	3.99	0.99995
Do you think that the application of AI will have a positive impact on increasing the efficiency of the enterprise's work?	1	5	4.17	0.92174

Note: Min (Minimum), Max (Maximum), M (Mean), SD (Standard Deviation)

Source: Authors

Below are the results of the Mann-Whitney U test. Using the Mann-Whitney U test, statistically significant differences in the opinions of respondents from different countries were found in connection with *Research 1*, namely the question - how informed are you about the opportunities offered by AI for optimizing business processes ($p<0.05$). Specifically, the mentioned test identified a statistically significant difference in the values of the dimensions of respondents coming from North Macedonia (Md=2.50) compared to respondents coming from the Republic of Serbia (Md=5.00), while this difference is of low intensity (U=972.5, z=-2.027, p=0.043, r= 0.2027). The optimization of business processes plays a crucial role in improving efficiency and competitiveness in today's dynamic industrial environment (Chen et al. (2023)).

In addition, for *Research 2*, using the same test, she identified statistically significant differences in the opinions of respondents who come from different countries with the questions - what are the capabilities of your employees for applying for AI and - are changes needed in your enterprise to implement AI. Specifically, the mentioned test identified a statistically significant difference in the values of the dimensions of respondents coming from North Macedonia (Md=3.50) compared to respondents coming from the Republic of Serbia (Md=2.75), while this difference is of low intensity (U=887.5, z=-2.635, p=0.008, r= 0.2635) for the question - what are the capabilities of your employees for applying for AI. Zhu et al. (2020) found that leaders should carefully consider employees' awareness of AI, their considerations regarding the technology, and their overall viewpoints, as these factors can influence whether employees fully accept the AI journey or decide to resign—taking with them valuable knowledge and skills. Likewise, the aforementioned test identified a statistically significant difference in the values of the dimensions of respondents coming from North Macedonia (Md=3.50) compared to respondents coming from the Republic of Serbia (Md=2.75), whereby this difference is of approximately medium intensity (U=852, z=-2.995, p=0.003, r= 0.2995) for the question are changes needed in your enterprise to implement AI (Table 4). SME managers must place growing emphasis on integrating emerging tools, such as AI, into their business operations to fully capitalize on their potential benefits. However, the inherently subjective and complex nature of this adaptation process poses significant challenges for conducting comprehensive analyses of its key determinants (Lemos et al., 2022).

Table 4. *Mann-Whitney U test results for Research 1 and Research 2*

Research 1

	How informed are you about the opportunities offered by AI for optimizing business processes?
Mann-Whitney U	972.500
Wilcoxon W	2247.500
Z	-2.027
Asymp. Sig. (2-tailed)	0.043

Research 2

	What are the capabilities of your employees for applying for AI?	Are changes needed in your enterprise to implement AI?
Mann-Whitney U	887.500	852.000
Wilcoxon W	2162.500	2127.000
Z	-2.635	-2.995
Asymp. Sig. (2-tailed)	0.008	0.003

Note: Grouping Variable: *Where does your enterprise operate?*

Source: Authors

Statistically significant differences in respondent answers across the two surveys were revealed by the Kruskal-Wallis test. In *Research* 1, in connection with the answer to the question - how informed are you about the opportunities offered by AI for optimizing business processes according to the years of operation of the enterprise n=100, Chi-Square = 12.623, df=3, p=0.006 (Table 5). By reviewing the mean (average) values of the ranks of the groups, it was observed that the agreement with the answer to the question - how informed are you about the opportunities offered by artificial intelligence for optimizing business processes is at the highest level among respondents whose enterprise they are employed in has been active for more than 20 years (Mean Rank=66.67), and least among those whose enterprise has been operating for 6-10 years (Mean Rank=42.95). Chen et al. (2023) also examines the role of AI in streamlining and improving business operations.

In *Research* 2, in connection with the answer to the question - what are the capabilities of your employees for applying for AI according to the years of operation of the enterprise n=100, Chi-Square = 9.388, df=3, p=0.025 (Table 5). By reviewing the mean (average) values of the ranks of the groups, it was observed that agreement with the answer to the question - what are the capabilities of your employees for applying for AI is at the highest level among respondents whose enterprise they are employed in has been active for 1-5 years (Mean Rank=58.79), and least among those whose enterprise has been operating for 11-20 years (Mean Rank=34.78). Bharadiya (2023) identified the primary obstacle to the adoption of artificial intelligence as the lack of preparedness among managers of SMEs to implement AI technologies. 21 TV, 2025 the findings indicate that top management support and the overall working environment moderate the relationship between managerial satisfaction and the effectiveness of business operations. Also in this research, in connection with the answer to the question - are changes needed in your enterprise to implement AI according to the years of operation of the enterprise n=100, Chi-Square = 9.177, df=3, p=0.027 (Table 5). By reviewing the mean (average) values of the ranks of the groups, it was observed that agreement with the answer to the question - are changes needed in your enterprise to implement AI is at the highest level among respondents whose enterprise they are employed in has been active for 11 - 20 years (Mean Rank=59.58), and least among those whose enterprise has been operating for 1 - 5 years (Mean Rank=39.34). Once again, the lack of extensive understanding about AI and its value generation processes is highlighted (Bharadiya et al., 2023).

Table 5. *Kruskal Wallis test results for Research 1 and Research 2*

Research 1

	How informed are you about the opportunities offered by AI for optimizing business processes?
Chi-Square	12.623
df	3
Asymp. Sig.	0.006

Research 2

	What are the capabilities of your employees for applying for AI?	Are changes needed in your enterprise to implement AI?
Chi-Square	9.388	9.177
df	3	3
Asymp. Sig.	0.025	0.027

Note: Grouping Variable: How long has your enterprise been actively operating?

Source: Authors

The Kruskal Wallis Test is further in *Research 1*, in connection with the answer to the question - how informed are you about the opportunities offered by artificial intelligence for optimizing business processes according to the business sector of the enterprise n=100, Chi-Square = 20.907, df=6, p=0.002 (Table 6). By reviewing the mean (average) values of the ranks of the groups, it was observed that agreement with the answer to the question - how informed are you about the opportunities offered by artificial intelligence for optimizing business processes is at the highest level among respondents whose enterprise in which they are employed performs activities in the IT and Technology sector (Mean Rank=83.08), and least among those whose enterprise operates in the Services sector (Mean Rank=38.18). AI techniques are transforming not only the business world but also a wide range of other industry sectors (Bharadiya et al., 2023). Also in this research, in connection with in response to the question - do you think that the introduction of AI will contribute to accelerated growth and sustainability of your enterprise in the future according to the business sector of the enterprise n=100, Chi-Square = 17.506, df=6, p=0.008 (Table 6). By reviewing the mean (average) values of the ranks of the groups, it was observed that the agreement with the answer to the question - do you think that the introduction of AI will contribute to accelerated growth and sustainability of your enterprise in the future processes is at the highest level among respondents whose enterprise operates in the Agriculture sector (Mean Rank=71.83), and the least among those enterprises whose employees perform activities in the IT and Technology sector (Mean Rank=32.00). Artificial Intelligence (AI) plays an essential role across different fields in addressing complex challenges. However, certain critical areas continue to pose difficulties for humans—for example, agriculture, which faces issues such as crop diseases, inadequate storage management, and ineffective pesticide control. AI offers promising solutions to these and many other problems (Jindal et al.,2021).

In *Research 2*, in connection with the answer to the question - do you think there is a need for the reorganization of teams or work structures to enable the AI adoption in shaping business policies according to the business sector of the enterprise n=100, Chi-Square = 14.367, df=6, p=0.026 (Table 6). By reviewing the mean (average) values of the ranks of the groups, it was observed that agreement with the answer to the question - do you think there is a need for the reorganization of teams or work structures to enable the adoption of AI in shaping business policies is the highest among the respondents whose enterprise in which they are employed performs activity in the IT and Technology sector (Mean Rank=82.00), and least among those whose enterprise operates in the Agriculture sector (Mean Rank=34.50). In recent years, artificial intelligence has exerted a profound influence across a wide range of industrial sectors, underscoring the necessity for enterprises to adapt to this transformative momentum and advance toward sustainable development. The study conducted by Espina-Romero et al. (2023) aimed to examine the industrial sectors most affected by artificial intelligence during the period 2018–2022. The findings reveal the increasing impact of artificial intelligence in sectors such as technology, finance, healthcare, environmental management, and construction. Geographically, the most significantly influenced sectors are located in Europe and Asia, whereas those in the Americas, Africa, and Oceania have experienced comparatively lesser effects. The AI effect is anticipated to exhibit substantial variability across different professions, depending on the predominance of either substitution or complementarity between AI and

human labour, as well as the extent to which occupational roles can be reorganized to accommodate new tasks (Fossen et al., 2024).

Table 6. *Kruskal Wallis test results for Research 1 and Research 2*

Research 1

	How informed are you about the opportunities offered by AI for optimizing business processes?	Do you think that the introduction of AI will contribute to accelerated growth and sustainability of your enterprise in the future?
Chi-Square	20.907	17.506
df	6	6
Asymp. Sig.	0.002	0.008

Research 2

	Do you think there is a need for the reorganization of teams or work structures to enable the adoption of AI in shaping business policies?
Chi-Square	14.367
df	6
Asymp. Sig.	0.026

Note: Grouping Variable: *In which industry or sector is your enterprise actively working?*

Source: Authors

Conclusions

In the current operating environment, AI is coming to the fore as a significant factor in the transformation of operating policies and processes. Numerous enterprises around the world are already using AI for data analysis, process automation, and other different segments where AI facilitates the work process. Global trends in artificial intelligence show that countries that invest in AI, especially in education and raising awareness about the use, benefits, but also dangers of AI, are already enjoying the benefits of this technology. According to the findings of the analysis, for the two Balkan countries of North Macedonia and Serbia, this is a unique moment for work dedicated to the development of AI in order to accelerate the transformation from a service to a product industry and to develop products and solutions that will be competitive on the global market. Both countries from the Western Balkans are in the initial phase of development, but have significant potential to accelerate their progress in the function of economic growth and technological development. On this path, we could conclude that Serbia is one step ahead of North Macedonia.

SMEs increasingly recognize AI as a tool for enhancing efficiency, optimizing resources, and improving decision-making processes. The study results indicate that all the respondents acknowledged the AI potential to improve operational efficiency. However, there is a clear unawareness among the respondents on the possibilities that AI offers in shaping operating policies, which points to the need for additional education and increased awareness among SMEs and employees.

The attitudes toward AI awareness and its potential uses showed statistically significant differences between respondents from the Republic of North Macedonia and the Republic of Serbia. Notably, respondents from Serbia reported a higher level of awareness compared to those from North Macedonia. Meaningful statistical differences were also identified in the workforce expertise for AI application and in perceptions of the need for organizational changes to enable AI implementation. The findings point that the respondents from Macedonia exhibit a greater need for adaptation and support in the process of integrating AI into operating policies compared to their counterparts in Serbia. Generally positive outlook of AI's impact on efficiency, growth, and business transformation exists, confirming that AI is expected to provide increased enterprise performance. However, the respondents still lack sufficient understanding with the specific AI opportunities for business policy development, showing a gap between perceived potential and actual knowledge. The perceptions and awareness regarding the implementation of artificial intelligence (AI) are significantly influenced by the sector of activity, geographical location, and operational duration of an enterprise. Suggested by the findings is that companies operating within the IT

sector are the most informed, organizationally prepared for AI adoption and transformation, and are better positioned to integrate AI technologies. Nevertheless, despite their preparedness, these enterprises approach the long-term benefits of AI implementation with caution. The emerging enterprises tend to exhibit a higher degree of flexibility and openness toward adopting innovative solutions and organizational changes. Analogously, mature enterprises demonstrate a greater resistance to change, often attributable to entrenched operating practices and resistance to organizational change. These insights reaffirm the prerequisite of designing customized AI implementation strategies customized according to the specific needs and characteristics of individual enterprises. AI, as a modern tool within the broader framework of digital transformation, contributes to enhancing operational efficiency, improving business processes, and strengthening market competitiveness. However, the successful implementation of such technologies depends on several critical factors, most notably the existence of a clearly defined strategy, an adequate level of digital literacy, and robust institutional support.

The technological maturity inequality, awareness, and access to resources between the Republic of North Macedonia and the Republic of Serbia emphasize the need for context-specific approaches to the implementation and integration of AI in business operations. In this regard, the following strategic directions and policy recommendations are proposed to facilitate the adaptation and practical application of AI in varying economic and institutional contexts: Development of a national AI strategy in the Republic of North Macedonia; Creation of appropriate legal regulations**;** Education and training for entrepreneurs and employees within companies; Promotion of public-private partnerships, start-up initiatives, and innovation; Implementation of pilot projects and development of flexible business models; Establishment of ethical standards and evaluation systems to assess the impact of AI in both the Republic of North Macedonia and the Republic of Serbia. Although the findings cannot be fully generalised due to the limited sample, they provide a good basis for future research in other sectors and in a wider international context. Following a systematic approach and the implementation of these recommendations, AI can become a primary driver of competitiveness, innovation, and sustainable economic development of the region.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

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Author Contributions

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Socio-demographic Factors and Their Influence on the Development of Entrepreneurial Potential of Students

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Abstract: This study investigates how various socio-demographic variables influence the entrepreneurial potential among university students. The research was conducted on a sample of 1,008 students from three countries: Serbia, Bosnia and Herzegovina and Belgium. The instruments applied were the Questionnaire of Entrepreneurial Traits (QET) and the Scale of Entrepreneurial Potential (SEP). The primary objective was to examine: (a) the role of gender in shaping entrepreneurial potential, (b) the influence of national context, (c) differences between urban and rural backgrounds, (d) the impact of students' material status, and (e) the relationship between academic performance and the development of entrepreneurial capacity. Canonical discriminant analysis confirmed significance and the structure of differences among students considering their gender, country of origin and different material status of students, and their scores on the dimensions of the Entrepreneurial Traits model QET as well as on the Entrepreneurial Potential model SEP. Canonical discriminant analysis did not confirm significance and the structure of differences among students considering their place of residence and success during studies in their scores on the dimensions of Entrepreneurial Traits model QET as well as on the Entrepreneurial Potential model SEP. The findings of this research indicate that socio-demographic factors have a significant impact on students' entrepreneurial potential, offering a valuable framework for future studies and analyses, particularly in the context of the growing importance of entrepreneurship in developing countries.

Keywords: *Socio-demographic, entrepreneurship, development, student population.*

Introduction

There is a growing interest in fostering entrepreneurship, particularly in developing countries where entrepreneurs are increasingly viewed as pivotal agents in addressing persistent economic challenges, such as high unemployment rates. Number of authors in their recent researches considers the phenomenon of entrepreneurship to be crucial implement of faster economic development (Apurba, 2023; Borah and Bhowal, 2023; Van Praag, Versloot, 2007; Parker, 2009; Audretsch and Peña 2012; Brixiova, 2013; Toma, Grigore, and Marinescu, 2014). In order to define factors that contribute the most to the development of entrepreneurship, recent literature review shows that different authors studied economic factors and their impact on entrepreneurship (Muithui et al., 2023; Parker, 2004; Sun, 2024; Wennekers et al., 2005) and on the other hand others examined influence of personality factors and education on entrepreneurship (Isma et al., 2023; Thomas and Muller, 2005; Yan, 2010; Martin, McNally and Kay, 2013; Pfeifer, Sarlija and Zekic Susac, 2016; Soomro et al., 2025; Suryadi and Anggraeni, 2023).

In this study we turn to the impact of sociodemographic factors and the importance of their influence on the development of entrepreneurship of student population. According to Thornton, Ribeiro-Soriano and Urbano, (2011) "international organizations such as the Organisation for Economic Co-operation and Development (OECD) and European Union (EU) are focusing on the environmental drivers of entrepre-

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neurship, especially the social and cultural factors that influence the individual career choice to be an entrepreneur and to create a new business (European Commission, 2004, 2006; OECD, 1998, 2000)" (p.106). Furthermore they conclude that social cultural factors and their influence on entrepreneurship remains under researched. Turker and Selcuk in their study of factors that affect student entrepreneurial potential conclude that society that is supportive towards entrepreneurship and fosters entrepreneurial activity of its younger population will as a result have a higher level of confidence among young entrepreneurs which leads to development of entrepreneurial activity. Gurol and Atsan, (2006) conclude that in order to define entrepreneurial characteristics of a society we need to closely examine different factors. Urbano and Alvarez (2013) researched the influence of institutions on entrepreneurial activity and their sample consisted of 36,525 individuals from 30 countries according to (GEM and IMD data for 2008). In their overall assessment they stated that: "while the regulative and normative environments encourage people to become entrepreneurs, a strong cultural-cognitive environment is needed to create a new firm" (p. 713). Global Entrepreneurship Monitor studies contextual factors like socio-cultural and demographical influence the process of forming our personality and influence our perception and the way we act (GEM, 2010).

In our study we will investigate different sociodemographic factors focusing on gender, country of origin, influence of rural and urban area of residence, material status of students, and influence of success during studies and try to assess how they influence entrepreneurial potential of students.

Hofsted et, al. (2004) in their research concludes that factors influencing the development of entrepreneurship in a society are multidimensional and complex. Nicolae, M., Ion, I. and Nicolae, E. (2016), in their study state: "that entrepreneurship phenomenon is currently understood as a reflection of the local competitive advantages and disadvantages of the external environment" (p 394). In our research we will focus on student population and examine sociodemographic factors and their influence on this part of population. According to Shinnar, Giacomin and Janssen, (2012) who used Krueger, Reilly, and Carsrud (2000) statement: "Students fac[e] an immediate career choice [and]...starting a business may be a realistic option" (p. 425).

This study employed two conceptual frameworks: the Entrepreneurial Traits Model (QET) and the Entrepreneurial Potential Model (SEP). The QET model encompasses six dimensions—unconventionality and creativity, achievement orientation and challenge acceptance, entrepreneurial self-efficacy, assertiveness and communication skills, positive attitudes toward entrepreneurship, as well as interest and knowledge related to entrepreneurial activity. The SEP model evaluates entrepreneurial potential through dimensions such as intellectual capacity, self-confidence, motivation, social interaction, physical constitution, emotional stability, extroversion, and organizational competence. The SEP instrument quantifies respondents' scores across these dimensions, with higher scores indicating a greater degree of entrepreneurial potential.

Liberty, Tunde and Tinuola (2016) conclude in their study that sociodemographic factors influence development of entrepreneurial activity. In this research we will assess the influence of following sociodemographic factors: (a) the role of gender in shaping entrepreneurial potential, (b) the influence of national context, (c) differences between urban and rural backgrounds, (d) the impact of students' material status, and (e) the relationship between academic performance and the development of entrepreneurial capacity.

Influence of gender on the development of entrepreneurial potential

Research conducted on the student population revealed that male students exhibit a higher readiness to initiate their own businesses and pursue entrepreneurial careers. This research also shows that even though women enjoy family support, they feel less self-confident to start their own business (Bela et al., 2021; Dabic et al., 2012; Martín-Gutiérrez et al., 2025). Despite encountering socio-economic challenges—such as limited resource access, market inequality, and persistent gender-based stereotypes—women exhibit resilience through strategies like professional networking, skill development, and continuous learning (Đurđević, 2025). Gupta and Bhawe (2007) researched proactive personality as a characteristic that is significantly associated to entrepreneurship. They assessed that this is especially evident in an environment that is not supportive towards potential entrepreneurs, this lack of support is characteristic for the environment of developing countries such as Serbia and Bosnia we are researching. They concluded in their research that more proactive woman had significantly more developed entrepreneurial potential, and that this fact held them back from becoming entrepreneurs because of the common stereotype that entrepreneurship is connected to male population and that proactivity is commonly associated as a masculine trait. Envick and Lim (2011) according to Bartos et al. (2015) examine in their study

of gender and entrepreneurial orientation in the sample of 4 countries: US, Korea, Malaysia and Fiji that male entrepreneurs are more prone to risk propensity behaviour, they display more aggressive behaviour when competing on the market than females do, they also discovered that males lead in regard to female population of US and Korea in regard to independent decision making, and males are also found to be more confident in decision making process across the sample. Differences in level of entrepreneurial development between genders can be explained by gender discrimination women face (Fischer et al., 1993). Since 1999, Global Entrepreneurship Monitor (GEM) provides data on the fact that women develop less entrepreneurial potential and stay behind men in entrepreneurship activity. Research results from Bulgaria show that women have less expressed entrepreneurial potential than men (Yordanova and Tarrazon, 2010), this survey is very interesting to our own study because of the similarity in the mentality in the region of Balkans. Bartos et al. (2015) conclude in their study that male entrepreneurs in Czech Republic are more aggressive than female entrepreneurs and more innovative. Shinnar, Giacomin and Janssen, (2012) in their research which is similar to our own used a sample of 761 university students from three different nations: Belgium, China and United States, their study pointed to the existence of significant influence of gender and culture for development of entrepreneurship in a society. Also, this research found that gender negatively influences the development of entrepreneurship through the society's lack of support for female entrepreneurship. Research conducted on student population in India shows that student gender is a factor that strongly influences the development of entrepreneurship (Sonia Katherin Mathew and Dr. Johney Johnson, 2014). Demographic factor like gender among others is strongly connected to self-employment and influences entrepreneurial potential of individuals (Wilson, Kickul and Marlinon, 2007).

Influence of rural and urban area of residence on entrepreneurial potential

Hyunjeong, (2011) in his research found that most of the literature collects data in urban settings and gives exzamples of Panel Study of Entrepreneurial Dynamics (PSED) and the Global Entrepreneurship Monitor (GEM). He concludes in his study that main difference between rural and urban entrepreneurship is in resources, rural areas lack in education and financial resources but show rich entrepreneurial potential. Different research point to the fact that the rate of entrepreneurial development is significantly lower in rural than in urban areas (Eurobarometer, 2007).

According to the research of Capelleras, Contín-Pilart, Martin-Sanchez and Larraza-Kintana, (2013) that used data from the Spanish GEM project, they found: "that individuals in rural areas who perceive new opportunities are more likely to become nascent entrepreneurs rather than those who live in urban ones" (p. 97). Urban environments are assumed to foster greater entrepreneurial intentions in students due to increased exposure to economic activities compared to rural environments (Al Harrasi and Ali, 2025). Rural and urban areas of residence significantly influence entrepreneurial potential among women entrepreneurs in Pakistan, with differences in home ownership, household size, and financial position (Muhammad and Ximei, 2022). Faggio and Silva (2014) in their research of self-employment and entrepreneurship in rural and urban markets argue that self-employment in rural and urban areas is not the part of the same phenomenon of entrepreneurship. They find that urban areas provide self-employment of working people based on innovative behaviour, risk taking propensity which form entrepreneurship, while rural workers more often engage in self-employment because they lack other job opportunities. According to Duricova (2014) Baumgartner et al., (2013) state that: "entrepreneurship has become a key topic in rural development" (p. 197). Duricova (2014), in her study on entrepreneurship across rural and urban regions within the EU, argues that individuals residing in underdeveloped rural areas are more inclined to engage in entrepreneurial activities compared to those living in more developed urban settings.

However, empirical findings on the influence of residential context remain inconsistent. While some studies suggest that urban environments exert a stronger impact on the development of entrepreneurial potential, others indicate that rural areas contribute equally to fostering entrepreneurial capabilities.

Influence of material status of students

Material status has a complex but generally positive influence on students' entrepreneurial potential, with financial resources serving as a key enabler of entrepreneurial intentions. The evidence suggests multiple dimensions of material status impact entrepreneurship. Li (Li et al., 2022) found materialism positively predicts entrepreneurial intention through a serial mediation involving achievement motivation,

while another author (Rajković et al., 2021) specifically noted that financial opportunities to start a new business was the most influential variable on entrepreneurial intentions. According to Lee and Persson, (2012) there are number of research that provide evidence of significant connection among personal wealth and propensity to start entrepreneurial activity (Alger and Weibull, 2010). Friedline and West, (2015) in their research examined the impact of wealth on young adults and their entrepreneurial activity. They concluded that young adults with lower material status encounter difficulties in acquiring financial resources needed to start their own business.

Hosseini (2016) states in his research that: "financial resources within the family stimulates entry into entrepreneurship" (p. 31). He even found that wealthier is the family background larger is the entrepreneurial venture individuals form. Research in the field of entrepreneurship show that entrepreneurial background in the family poses a source of different assets for the new entrepreneurs in the family, such as financial resources, suppliers, connections in the market, connection with the suppliers and knowledge of needed technologies (Dunn and Holtz-Eakin, 2000). According to Mustapha and Selvaraju, (2015) family also stimulates students by creating a supportive environment which provides them with resources and knowledge that help them start their entrepreneurial activity after they finish their studies (Bagheri and Pihie, 2010).

OECD and European Commision (2014) consider that young people are more prone to entrepreneurial activity, but statistics shows that their rate of becoming entrepreneurs is lower than one of the adults. They state that: "this is the result of barriers related to lack of awareness, orientation of education and training, lack of experience, fewer financial resources, limited networks, and market barriers". OECD and European Commision (2014) also imply that EU entrepreneurship programs can overcome these obstacles. One of the programs is The Youth Employment Initiative (YEI) Activities supported include: "encourage schools and employment services to promote and provide continued guidance on entrepreneurship and self-employment for young people". This can be very important and helpful for the young people coming from families with lower material status. Motivation and support they lack at home they can overcome by formal programs and entrepreneurship education. According to Jiménez, Palmero-Cámara, González-Santos, González-Bernal, Jiménez-Eguizábal, (2015) in their research they concluded that education influences the increases of entrepreneurial activity, and it is connected to the level of the higher self-confidence, lower perceived risk and enhanced human capital.

Influence of success during studies on the development of entrepreneurial potential of students

The influence of academic success factors such as education, motivation, practical experience, and social support positively impacts students' readiness to become entrepreneurs, as they have great potential to start businesses with innovative ideas, relevant skills, and necessary resources (Marpaung et al., 2023). Anderson, Samimi, and Boh (2010) in their book asses that academic success and formal education can be a "security ceiling" that is hard to escape and embrace other possibilities outside the given framework of a false feeling of security. Ward (2004) in his research states: "More than ever we need to prepare young people to build a life of purpose and opportunity in which they are aware of and can draw on their various talents and abilities. Enterprise Education offers a framework for this kind of learning" (p. 105). Sharma and Madan, (2014) found in their research that students with high scores on intelligence tests had low propensity towards entrepreneurship but attendance of entrepreneurship courses resulted in higher propensity towards entrepreneurship. Chad Moutray (2009) examined the Department of Education data in the USA and found that students with better academic achievement had slightly less chances of being self-employed and becoming entrepreneurs. Research conducted on student population in India shows that student age is a factor that strongly influences the development of entrepreneurship (Sonia Katherin Mathew and Dr. Johney Johnson, 2014). Peterman and Kennedy (2003) conclude that different educational programs can significantly influence development of entrepreneurship. Several studies (Gyang et al., 2023; Machado et al., 2022; Mumtaz et al., 2024) provide comprehensive evidence that entrepreneurial education significantly enhances students' entrepreneurial potential across different educational contexts and geographic regions. Gyang et al. (2023) specifically identified self-efficacy as a critical mediating factor, showing that education builds students' confidence in their entrepreneurial abilities, while Machado et al. (2022) added academic engagement as another important mechanism, demonstrating that entrepreneurial education creates more engaged learners with higher entrepreneurial potential. Mumtaz et al. (2024) confirmed that students develop positive attitudes, subjective norms, and

behavioral control - all key components of entrepreneurial intention. The same author identified a critical gap between students' entrepreneurial potential and current curriculum offerings, suggesting that while the impact is positive, educational systems need improvement to fully capitalize on students' entrepreneurial capacity. Levesque and Minniti (2006) in their research revealed that age is significantly connected to entrepreneurial potential and activity. Students that are older have more experience and attend more entrepreneurial courses and consequently have more developed entrepreneurial potential, so attendance of entrepreneurial programs and courses shows more impact on development of entrepreneurial potential than student academic success. Above literature survey implies that academic success does not provide a pattern that detects significant relation between academic success and development of entrepreneurship potential of students.

Materials and Methods

Research methodology

The primary aim of this study is to examine the influence of various socio-demographic factors on the entrepreneurial potential of university students. The research utilized two key instruments: the Questionnaire on Entrepreneurial Traits (QET) and the Scale of Entrepreneurial Potential (SEP). Five groups of socio-demographic factors were analysed: (a) the role of gender in shaping entrepreneurial potential, (b) the influence of national context, (c) differences between urban and rural backgrounds, (d) the impact of students' material status, and (e) the relationship between academic performance and the development of entrepreneurial capacity.

In this paper we hypothesize that students with different demographic background differ from each other in terms of expression of certain dimensions of entrepreneurial potential models QET and SEP.

Data collection and descriptive statistics

The research sample comprised university students from three countries—Serbia and Bosnia and Herzegovina, as EU candidate countries, and Belgium, an EU Member State. Participants were recruited from three universities and eleven faculties, resulting in a total of 1,008 respondents, including 589 male and 419 female students. The study adhered to ethical research standards, including institutional approval from participating universities. Questionnaires were administered during regular class sessions, ensuring respondent anonymity and the exclusive use of data for scientific purposes. Participants reported clear understanding of the instructions, and no issues were encountered during the data collection process.

Instruments

This study employed two primary instruments: the Scale of Entrepreneurial Potential (SEP) and the Questionnaire of Entrepreneurial Traits (QET). The SEP scale assesses entrepreneurial potential across eight sub-scales: intellectual abilities, self-confidence, motivation, social relations, physical constitution, emotional stability, extroversion, and organizational skills.

Each SEP sub-scale captures a distinct dimension of entrepreneurial potential. The intellectual abilities sub-scale evaluates resourcefulness in various situations, the capacity for independent problem-solving and decision-making, as well as a proactive attitude toward learning and personal development. The self-confidence sub-scale measures boldness in expressing personal views and assertiveness in social and professional contexts.

The physical constitution sub-scale reflects aspects of physical fitness, energy, and endurance, which are considered relevant to sustained entrepreneurial engagement. The organizational skills sub-scale assesses individuals' preference for managerial roles and their ability to effectively plan, structure, and execute tasks.

The extroversion sub-scale—referred to as openness in earlier conceptualizations—includes traits such as risk-taking propensity, openness to new experiences, and creativity. The motivation sub-scale encompasses competitive spirit, grit, initiative, goal orientation, ambition, perseverance, dedication, and work ethic.

The emotional stability sub-scale evaluates an individual's self-regulation, resilience under stress, emotional balance, and general optimism. Finally, the social relations sub-scale measures leadership potential, communicative competence, social influence, teamwork orientation, adaptability, conflict resolu-

tion skills, and the ability to make a positive impression in social settings

The SEP inventory consists of 34 items designed to assess respondents' scores across the eight sub-scales representing different dimensions of entrepreneurial potential. The total entrepreneurial potential score is calculated by summing the scores across all sub-scales, with higher total scores indicating stronger entrepreneurial potential. This instrument was developed specifically for the purposes of this study, based on theoretical frameworks and prior research on entrepreneurial characteristics.

Responses were recorded using a 5-point Likert-type scale, ranging from "strongly agree" to "strongly disagree." Confirmatory factor analysis supported the factorial validity of the inventory, and the instrument demonstrated acceptable reliability, with Cronbach's alpha coefficients ranging from 0.751 to 0.756 across individual sub-scales.

The Questionnaire of Entrepreneurial Traits (QET), developed by Gracanin and Coso (2013), is designed to assess entrepreneurial self-efficacy and attitudes toward entrepreneurship. The inventory comprises 58 items and evaluates six sub-scales: entrepreneurial unconventionality and creativity, focus on achievement and acceptance of challenges, entrepreneurial self-efficacy, assertiveness and communication, positive attitudes toward entrepreneurship, and interest in entrepreneurship and knowledge. The total QET score is obtained by summing scores across all sub-scales, with higher values indicating a greater level of entrepreneurial potential.

The QET inventory evaluates six interrelated sub-scales that collectively capture key dimensions of entrepreneurial traits. The first sub-scale, unconventionality and creativity, reflects an individual's tendency to approach problem-solving in original and non-traditional ways, often involving a willingness to take risks. It also measures self-perceived creativity and confidence in utilizing these traits. The second sub-scale, focus on achievement and acceptance of challenges, pertains to one's motivation to tackle complex tasks and engage in activities with uncertain outcomes, demonstrating a readiness to embrace challenges as part of the entrepreneurial process. The third sub-scale, entrepreneurial self-efficacy, is the most extensive and central within the inventory. It assesses confidence in personal entrepreneurial capabilities, persistence in goal pursuit, general entrepreneurial orientation, and leadership potential. The fourth sub-scale, assertiveness and communication, captures interpersonal skills vital to entrepreneurship, particularly the ability to express ideas clearly and interact effectively with others. The fifth sub-scale, positive attitudes toward entrepreneurship, evaluates favorable perceptions of entrepreneurs and entrepreneurship, along with an individual's openness to becoming an entrepreneur. Lastly, the sixth sub-scale, interest in entrepreneurship and knowledge, focuses on self-assessed understanding of entrepreneurial concepts and the extent of recent learning in this domain.

All responses were collected using a 5-point Likert-type scale, ranging from "strongly agree" to "strongly disagree." Confirmatory factor analysis supported the factorial validity of the instrument, confirming its underlying structure. In the present study, the QET demonstrated satisfactory reliability, with Cronbach's alpha coefficients ranging from 0.732 to 0.805 across the sub-scales.

Data analysis

The data were processed using the statistical software packages Statistica and SPSS. Descriptive statistics were employed to examine the basic characteristics of the sample and the distribution of variables. To assess the existence and strength of relationships between the observed variables, canonical discriminant analysis was conducted. This method enabled the identification of socio-demographic factors that most significantly differentiate levels of entrepreneurial potential among student respondents.

Results

The significance and structure of gender differences in scores on the dimensions of the QET questionnaire were determined using canonical discriminant analysis.

Table 1. *Indicators of the significance of discriminant functions in separating groups*

Function	Λ	% of variance explained	Rc (canonical correlation)	Λ_w partial Wilks' Lambda	χ^2 (chi-square statistic)	df (chi-square statistic)	P (p-value)
1	.038	100.0	.190	.964	37.058	6	.000

Male students have higher scores on the dimensions Positive Attitudes toward Entrepreneurs and Interest in Entrepreneurship, Entrepreneurial Self-Efficacy and Assertiveness and Communication, and lower scores on Knowledge (ΛW=.964, χ2 (df=6)= 37.058, p<0.01). The ability of these two functions to classify respondents was 57.6 %.

Table 2. *Structural matrix and discriminant function values at group centroids*

Function – Indicator	*Coefficient*
Entrepreneurial self-efficacy	.642*
Assertiveness and communication	.576*
Knowledge	-.488*
Positive attitudes toward entrepreneurs and interest in entrepreneurship	.331*
Unconventionality and creativity	.251
Achievement orientation and acceptance of challenges	.183
Function at group centroids	
Male	.163
Female	-.230

Legend:* indicates a statistically significant structural coefficient

Canonical discriminant analysis was used to determine the significance and structure of gender differences between male and female students in scores on the dimensions of the SEP questionnaire.

Table 3. *Indicators of the significance of discriminant functions in separating groups*

Function	Λ	% of variance explained	Rc	ΛW	χ^2	df	p
1	0.032	100.0	0.177	0.969	31.927	8	0.000

Male students have higher scores on Motivation (ΛW=.969, χ2 (df=8)= 31.927, p<0.01). The classification accuracy of this function was 56.7%.

Table 4. *Structural matrix and discriminant function values at group centroids*

Function – Indicator	Coefficient
Motivation	–0.513*
Openness	–0.215
Self-confidence	0.161
Constitution	0.149
Intellectual abilities	–0.097
Social relationships	–0.073
Emotionality	0.042
Organizational abilities	0.011
Function at group centroids	
Male	-.152
Female	.213

Legend:* indicates a statistically significant structural coefficient

Canonical discriminant analysis was used to determine the differences and the structure of differences between students from different countries in scores on the dimensions of the QET questionnaire.

Table 5. *Indicators of the significance of discriminant functions in separating groups*

Function	Λ	% of variance explained	Rc	ΛW	χ^2	df	p
1	0.066	65.8	0.249	0.907	97.756	12	0.000
2	0.034	34.2	0.182	0.967	33.747	5	0.000

The results indicate that students from Belgium, when compared to their peers from Bosnia and Herzegovina, scored significantly higher on the QET sub-scales Positive Attitudes toward Entrepreneurs and Interest in Entrepreneurship, Unconventionality and Creativity, Entrepreneurial Self-Efficacy, and Assertiveness and Communication, while exhibiting lower scores on the Knowledge. These differences were statistically significant ($\Lambda W = 0.907$, $\chi^2(df = 12) = 97.756$, $p < 0.01$).

Furthermore, in comparison to students from Serbia, Belgian students demonstrated significantly higher scores on the sub-scales Entrepreneurial Self-Efficacy, Assertiveness and Communication, Achievement Orientation and Acceptance of Challenges, and Knowledge ($\Lambda W = 0.967$, $\chi^2(df = 5) = 33.747$, $p < 0.01$).

The overall classification accuracy of the two discriminant functions was 45.5%, with the lowest classification precision observed among students from Serbia, indicating greater overlap in their entrepreneurial trait profiles relative to the other groups.

Table 6. *Structural matrix and discriminant function values at group centroids*

Dimension	**Function 1**	**Function 2**
Positive Attitudes toward Entrepreneurs and Interest	0.620*	0.244
Unconventionality and Creativity	0.505*	–0.106
Entrepreneurial Self-Efficacy	0.503*	0.709*
Assertiveness and Communication	0.416*	0.701*
Achievement Orientation and Acceptance of Challenges	0.242	0.603*
Knowledge	–0.469*	0.565*
Function at group centroids		
Serbia	0.077	0.053
Bosnia and Herzegovina	–0.767	–0.069
Belgium	0.227	–0.819

Legend: *statistically significant structural coefficient

Canonical discriminant analysis was used to determine the differences and the structure of differences between students from different countries in scores on the dimensions of the SEP questionnaire.

Table 7. *Indicators of the significance of discriminant functions in separating groups*

Function	Λ	% of variance explained	Rc	ΛW	χ^2	df	p
1	0.043	77.9	0.204	0.947	54.617	16	0.000
2	0.012	22.1	0.110	0.988	12.198	7	0.094

Students from Bosnia and Herzegovina, in comparison to their peers from Belgium, demonstrated significantly higher scores across all dimensions of the SEP model ($\Lambda W = 0.947$, $\chi^2(df = 16) = 54.617$, $p < 0.01$). The most discriminating dimensions contributing to this difference were Organizational Abilities, Social Relationships, Self-Confidence, Constitution, and Motivation.

The second discriminant function did not significantly distinguish the groups of students from differ-

ent countries. The classification accuracy of these two functions was 36.5%, with the poorest classification results observed among students from Serbia.

Table 8. *Structural matrix and discriminant function values at group centroids*

Dimension	Function 1
Organizational Abilities	0.818*
Social Relationships	0.793*
Self-Confidence	0.694*
Constitution	0.664*
Motivation	0.584*
Openness	0.524*
Emotionality	0.362*
Intellectual Abilities	0.392*
Function at group centroids	
Serbia	0.005
Bosnia and Herzegovina	0.342
Belgium	–0.822

Legend: *statistically significant structural coefficient

Canonical discriminant analysis did not find a statistically significant difference between students from different places of residence in scores on the dimensions of the QET questionnaire ($\Lambda W = 0.996$, $\chi^2(df = 6) = 3.556$, $p > 0.05$).

Table 9. *Indicators of the significance of discriminant functions in separating groups*

Function	Λ	% of variance explained	Rc	ΛW	χ^2	df	p
1	0.004	100.0	0.059	0.996	3.556	6	0.736

Canonical discriminant analysis did not find a statistically significant difference between students from different places of residence in scores on the dimensions of the SEP questionnaire ($\Lambda W = 0.997$, $\chi^2(df = 8) = 3.068$, $p > 0.05$).

Table 10. *Indicators of the significance of discriminant functions in separating groups*

Function	Λ	% of variance explained	Rc	ΛW	χ^2	df	p
1	0.003	100.0	0.055	0.997	3.068	8	0.930

Canonical discriminant analysis was used to determine the differences and the structure of differences between students with different material status on the dimensions of the QET questionnaire.

Table 11. *Indicators of the significance of discriminant functions in separating groups*

Function	Λ	% of variance explained	Rc	ΛW	χ^2	df	p
1	0.075	88.5	0.265	0.921	82.581	12	0.000
2	0.010	11.5	0.099	0.990	9.792	5	0.081

Students with below-average material status scored significantly higher on the Knowledge ($\Lambda W = 0.921$, $\chi^2(df = 12) = 82.581$, $p < 0.01$) compared to those with average material status. The second discriminant function did not significantly distinguish the groups of students with different material status. The classification accuracy of these two functions was 45.9%, and students from all categories were classified with roughly equal success.

Table 12. *Structural matrix and discriminant function values at group centroids*

Dimension	Function 1
Knowledge	0.898*
Unconventionality and Creativity	–0.128
Assertiveness and Communication	–0.143
Achievement Orientation and Acceptance of Challenges	–0.127
Positive Attitudes toward Entrepreneurs and Interest	–0.056
Entrepreneurial Self-Efficacy	–0.229
Function at group centroids	
Below-average	.440
Average	–0.182
Above-average	0.191

Legend: *statistically significant structural coefficient

Canonical discriminant analysis was used to determine the differences and the structure of differences between students with different material status on the dimensions of the SEP questionnaire.

Table 13. *Indicators of the significance of discriminant functions in separating groups*

Function	Λ	% of variance explained	Rc	ΛW	χ^2	df	p
1	0.033	79.0	0.179	0.959	41.553	16	0.000
2	0.009	21.0	0.094	0.991	8.828	7	0.265

Students with above-average material status, compared to those with average status, have higher scores on Social Relationships, Organizational Abilities, Self-Confidence, and Openness ($\Lambda W = 0.959$, $\chi^2(df = 16) = 41.553$, $p < 0.01$). The second discriminant function did not significantly distinguish the groups of students with different material status. The classification accuracy of these two functions was 42.5%, with the poorest classification observed among students with below-average material status.

Table 14. *Structural matrix and discriminant function values at group centroids*

Dimension	Function 1
Social Relationships	0.684*
Organizational Abilities	0.587*
Self-Confidence	0.356*
Openness	0.298M
Motivation	0.288
Intellectual Abilities	0.253
Constitution	0.126
Emotionality	–0.262
Function at group centroids	
Below-average	0.220
Average	–0.119
Above-average	0.439

Legend: *statistically significant structural coefficient

M - marginally significant coefficient

A multiple regression analysis was conducted to determine whether the dimensions of the applied models predict student success. This analysis was conducted only on the 208 students who responded to this question.

It was not established that the dimensions of the QET model predict academic success (adjusted $R^2 = –0.01$, $F(6, 201) = 0.674$, $p > 0.05$).

It was not established that the dimensions of the SEP model predict academic success (adjusted $R^2 = 0.03$, $F(8, 199) = 1.769$, $p > 0.05$).

Table 15. *Significance of the multiple regression model*

Model	R	R^2	Adjusted R^2	df reg	df res	F	p
QET	0.140	0.020	–0.010	6	201	0.674	0.670
SEP	0.258	0.066	0.029	8	199	1.769	0.085

Discussion

The entrepreneurial potential of young people represents a category of dynamic and complex nature, and as such is subject to the action of various internal and external factors, some of which are hereditary, static and unchanging in nature, while others are subject to minor or major variations and changes (GEM, 2010; Liberty, Tunde and Tinuola, 2016; Martin, McNally and Kay, 2013; Parker, 2004; Pfeifer, Sarlija and Zekic Susac, 2016; Thomas and Muller, 2013; Yan, 2010). The main goal of this paper was to examine the effect of five groups of socio-demographic factors on the development of dimensions of entrepreneurial potential among the student population: gender, country and place of residence, material status and success in studies. Entrepreneurial characteristics are theoretically defined and operationally measured with the help of two models of entrepreneurial potential - QET and SEP. The central research assumption posited that students would differ in the expression of specific entrepreneurial characteristics, as measured by the QET and SEP models, depending on the influence of various socio-demographic factors. The study showed that the expressiveness of the students' entrepreneurial potential is related to three categories of socio-demographic factors - gender, country, and financial status of the respondents.

Regarding the relationship between gender and the expression of entrepreneurial potential, the findings confirmed the existence of gender-based differences across several dimensions of the QET and SEP models. Specifically, within the QET model, male students exhibited significantly higher scores on the sub-scales positive attitudes toward entrepreneurs and interest in entrepreneurship, entrepreneurial self-efficacy, and assertiveness and communication, while scoring lower on the interest in entrepreneurship and knowledge sub-scale compared to female students. Also, the results showed that male students have a more pronounced dimension of Motivation, within the SEP model. This finding is expected and speaks of a more pronounced entrepreneurial potential in the male population, in the domain of most entrepreneurial traits (Bartos et al., 2015; Bela et al., 2021; Dabic et al., 2012; Fischer et al., 1993; Gupta and Bhawe, 2007; Martín-Gutiérrez et al., 2025; Mathew and Johnson, 2014; Shinnar, Giacomin and Janssen, 2012; Wilson, Kickul and Marlinon, 2007; Yordanova and Tarrazon, 2010).

When considering the characteristics of the development of certain traits through evolution, the characteristics of the current socio-cultural environment and the specifics of occupations that have traditionally been considered predominantly male, and this certainly includes entrepreneurship, the obtained findings have their deep evolutionary and social roots (Dabic et al., 2012; Gupta and Bhawe, 2007; Mathew and Johnson, 2014). Namely, throughout the evolutionary period, the qualities of proactivity, independence, fighting spirit, and willingness to openly and directly advocate for one's own goals, and even to take certain risks and deviate from the expected norms and rules, when the situation so dictates, were encouraged in men (Bartos et al., 2015; Wilson, Kickul and Marlinon, 2007).Traditionally, the socialization and education of women have emphasized traits such as modesty, adherence to social norms, and behavioral conformity, often reinforcing passivity and a dependence on expected roles—primarily within the family sphere—while placing less emphasis on career independence or entrepreneurial aspirations. This orientation has frequently directed women toward traditionally female-dominated occupations (Fischer et al., 1993; Shinnar, Giacomin, and Janssen, 2012; Yordanova and Tarrazon, 2010). In light of these historical and cultural patterns, it is not surprising that male students tend to show greater interest in entrepreneurship, express more positive attitudes toward entrepreneurial careers, demonstrate higher confidence in goal achievement, display stronger assertiveness and communication skills, and exhibit greater overall motivation for entrepreneurial engagement.

The finding that female students exhibit higher levels on the interest in entrepreneurship and knowl-

edge sub-scale is encouraging, as it indicates the presence of a critical cognitive predisposition for engaging in entrepreneurial activity. However, the results also suggest that they may lack, to some extent, the necessary motivation, self-confidence, and active interest to translate this knowledge into entrepreneurial behavior. These insights should be carefully considered when designing and implementing programs aimed at fostering female entrepreneurship. Such initiatives should begin by cultivating motivation and entrepreneurial interest among young women, with the goal of empowering them to independently pursue and succeed in entrepreneurial careers (Karnavat et al., 2024; Wilson, Kickul and Marlinon, 2007; Yordanova and Tarrazon, 2010).

The results also confirmed significant cross-national differences in the expression of entrepreneurial potential dimensions, as measured by both the QET and SEP models, among students from the countries included in the study.Thus, compared to students from BiH, students from Belgium have more developed dimensions Positive attitudes about entrepreneurs and interest in entrepreneurship, Unconventionality and creativity, Entrepreneurial self-efficacy and Assertiveness and communicativeness, and less expressed Knowledge, within the QET model. At the same time, compared to students from Serbia, students from Belgium have more pronounced dimensions Entrepreneurial self-efficacy, Assertiveness and communicativeness, Orientation to achievement and acceptance of challenges and Knowledge. This finding is expected and speaks in favor of the fact that young people from the EU have a more developed majority of characteristics that make them predisposed to engage in entrepreneurship. On one hand, these differences may reflect specific socio-cultural contexts in which young people are socialized, particularly in Western European countries. In these settings, educational systems and societal norms tend to emphasize achievement orientation, independence, self-reliance, a proactive approach to problem-solving, as well as the cultivation of uniqueness and creativity from an early age (Bartos et al., 2015; Gupta and Bhawe, 2007; Pfeifer, Sarlija and Zekic Susac, 2016; Urban and Alvarez, 2013; Yordanova and Tarrazon, 2010), while on the other hand, different more specific educational contents and methods, starting from preschool institutions up to higher education institutions, as well as direct programs intended to encourage and develop entrepreneurship (GEM, 2010; European Commission, 2004, 2006, 2014; Martin, McNally and Kay, 2013; OECD, 1998, 2000, 2014; Thomas and Muller, 2005; Yan, 2010), in children and young people during their entire growing up, develop entrepreneurial qualities and foster an entrepreneurial spirit.

The findings show that compared to students from Belgium, students from Bosnia and Herzegovina have more developed all dimensions of the SEP model, where they are best distinguished by the development of the dimensions of Organizational Ability, Social Relations, Self-Confidence, Constitution and Motivation. Although somewhat unexpected, this finding is nonetheless encouraging, as it demonstrates that young people from developing, non-EU countries possess several core attributes of entrepreneurial potential—such as organizational skills, social relations, self-confidence, and motivation—despite facing different socio-economic conditions. These results underscore the importance of further strengthening and guiding these existing capacities through targeted educational initiatives and concrete entrepreneurship support programs. Given that the entrepreneurial potential of youth is a key driver of social transformation and broader socio-economic development, especially in transitional contexts, investing in the entrepreneurial empowerment of young individuals from outside the EU is both a strategic and necessary endeavor (Audretsch and Peña 2012; Baporikar, 2020; Brixiova, 2013; Čeko and Rađenović-Kozić, 2023; Kudysheva, 2020; Parker, 2009; Sarlija and Susac, 2010; Sulejman, 2020; Toma, and Marinescu, 2013; Yordanova and Tarrazon, 2010).

The results did not show the existence of significant differences between students from urban and rural areas in the expressiveness of the entrepreneurial potential dimensions of the QET and SEP models. The results of previous studies in this domain are not completely unambiguous (Capelleras et al., 2013; Duricova 2014; Faggio and Silva, 2014; Al Harrasi and Ali, 2025; Hyunjeong, 2011; Muhammad and Ximei, 2022) and this finding points to the fact that young people in urban and rural areas have equally developed entrepreneurial abilities, skills, knowledge, motivation, and interests needed to engage in entrepreneurship. To a certain extent, this finding gives a positive picture, when it comes to the urban and rural population and its readiness to engage in entrepreneurial occupations, which speaks of positive tendencies and opportunities for growth and development, both in urban and rural areas (Capelleras et al., 2013; Duricova 2014). On the other hand, if certain incentive programs are planned for the development of entrepreneurship and the entrepreneurial potential of the population, it is necessary to organize

and implement them, with equal intensity, both in urban and rural areas, whereby the specificities and needs characteristic of the given environment can be included in concrete incentives and activities (Faggio and Silva, 2014; Hyunjeong, 2011).

When it comes to the effect of financial status on the development of entrepreneurial potential among young people, differences between students of different financial status were confirmed in terms of the expressiveness of the dimensions of the QET and SEP models. The analysis revealed that students with below-average financial status scored higher on the interest in entrepreneurship and knowledge subscale of the QET model compared to those with average financial status. In contrast, students with above-average financial status demonstrated significantly higher scores on the SEP sub-scales social relations, organizational skills, self-confidence, and extroversion, relative to students with average financial status. These findings suggest that different dimensions of entrepreneurial potential may be deferentially influenced by students' material conditions.This result indicates that young people who are in a better financial condition have more developed key qualities for engaging in entrepreneurship, such as organizational skills, self-confidence, and openness to change, skills in social contacts. It is possible that the material condition alone directly provides them with certain security, self-confidence and openness to various opportunities (Alger and Weibull, 2010; Friedline and West, 2015; Hosseini, 2016; Lee and Persson, 2012), while there is also the possibility that the good material condition of such young people is a consequence of growing up in a stimulating environment, where the entrepreneurial spirit and entrepreneurship are nurtured, which further represents an additional factor that contributes to their development of entrepreneurial potential (Bagheri and Pihie, 2010; Dunn and Holtz-Eakin, 2000; Li et al., 2022; Mustapha and Selvaraju, 2015; Rajković et al., 2021). Young people who are of lower material status only have a more developed dimension of knowledge, which is very encouraging and can have positive effects, if in the educational sense they are directed in a timely manner towards the development of other entrepreneurial capacities and skills, and especially motivated through various stimulating programs for engaging in entrepreneurship (Jiménez et al., 2015; OECD and European Commission, 2014).

An interesting finding of the study is that students' academic success does not exhibit a direct correlation with the dimensions of entrepreneurial potential as measured by the QET and SEP models. This suggests that the core characteristics underlying entrepreneurial potential may operate independently of traditional academic performance, reflecting distinct cognitive, motivational, and behavioral traits not necessarily captured by academic achievement alone. and speaks of the fact that they are more related to practical abilities, skills and action, and less to the general success in the academic community, theoretical knowledge and skills needed to achieve success in learning, in a narrower sense, but without the application of knowledge (Anderson, Samimi and 2010; Machado et al., 2022; Moutray, 2009; Mumtaz et al., 2024; Sharma and Madan, 2014). The absence of a direct link between academic success and entrepreneurial potential—along with the recognition that academic achievement alone does not guarantee success in entrepreneurship—highlights the need to broaden educational content and methodologies. Specifically, curricula should be expanded to actively foster the development of entrepreneurial potential among young people. This includes promoting students' readiness to engage in entrepreneurship through practical, experience-based learning formats such as hands-on teaching practice, independent project work, and guided mentorship. Crucially, these activities should take place in environments that closely simulate real-world conditions and future workplace settings, thereby enhancing the relevance and applicability of entrepreneurial education (Levesque and Minniti, 2006; Mathew and Johnson, 2014; Peterman and Kennedy, 2003; Sharma and Madan, 2014; Ward, 2004).

Conclusions

The results of this research confirmed that various socio-demographic factors influence the expression of the entrepreneurial potential of young people. Thus, it was confirmed that young male respondents, students from the EU, as well as respondents with a better financial status have better developed most entrepreneurial traits, while young people from urban and rural areas, as well as students of different academic success, do not differ from each other in terms of the development of dimensions of entrepreneurial potential.

Analyzing the social and economic background of the countries from which the respondents in-

volved in this research come from, we can already detect major differences in the social structure and class system that could provide interesting insight for future research. Respondents from Bosnia and Herzegovina and Serbia come from, a decades long socialist system that now days evolved in market economy having a very harsh trasitional period. While respondents from Belgium as an EU country come from a decedes long capitalist system, that nurtured entrepreneurship as its core value. This alone points to major differences of the respondents perspective of researched phenomenon. Future research comparing post socialist societies and the differences in the development of entrepreneurship in regard to developed countries could be potentially very interesting.

The results obtained in this study hold considerable significance for both theoretical and practical domains. Theoretically, they enhance the conceptual understanding of entrepreneurial potential, offering insights into its multidimensional structure and the socio-demographic factors that shape the development of specific dimensions. Practically, the findings open important avenues for the more effective planning and implementation of educational interventions and entrepreneurship support programs. These programs should be strategically designed to promote female entrepreneurship, support entrepreneurial initiatives in transitional economies at various stages of EU accession, and empower socially vulnerable populations—particularly individuals from lower socio-economic backgrounds. Furthermore, the results highlight the need for a thorough revision and innovation of school and university curricula, with the aim of systematically fostering entrepreneurial potential among children and youth through the development of relevant cognitive, emotional, social, and behavioral traits. Possible limitations of the study simultaneously open questions for future research, in which it would be expedient to include primary and secondary school students, to expand the number of countries included in the sample, especially those from the EU, as well as to examine potential interactions between various socio-demographic factors, with the aim of creating a more comprehensive model of the action of various factors of entrepreneurial potential in children and young people.

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Conflict of interests

The authors declare no conflict of interest.

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The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

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Author Contributions

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Online vs. Face-to-Face Teaching: Advantages and Challenges from Students' Perspective

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Abstract: The aim of this research was to examine students' perceptions of online and face-to-face teaching by combining quantitative and qualitative research approaches. The research was conducted on a sample of 524 students, and the general results confirm that students are more oriented towards face-to-face rather than online classes. Online teaching is recognized as a more flexible form of learning that enables better organization of time, spatial independence, economy and greater availability of teaching content. This form of learning is often accompanied by a lack of motivation, limited social interaction with professors and colleagues, as well as technical and other difficulties that affect the quality of acquired knowledge. On the contrary, face-to-face teaching is perceived as more stimulating for learning, as it provides direct contact, better exchange of information and a higher level of engagement and motivation, although it is less economical and requires more time resources. The obtained results indicate the need to combine the best aspects of both forms of teaching, which include flexibility and digital possibilities of online learning with direct contact and motivational effects of traditional teaching.

Keywords: *online teaching, face-to-face teaching, students, quality of learning, higher education.*

Introduction

Today, direct instruction is based on modern pedagogical concepts that aspire to a school culture dominated by learning strategies in which students are significantly more involved and activated in the teaching process. However, we often witness that, despite modern learning strategies and dedicated work of teachers, part of the students prefers to master the teaching material through online teaching, which marked the era of digitization. On the other hand, when a student from the school bench, who has understood and adopted the material, "explains" it to another student in "their" way, it becomes much easier and more comprehensible. The question arises, how is it possible that, despite the teacher's expertise and competence, the implemented material represents an obstacle for the student, while with the tools provided for online teaching, it becomes much easier? Such examples are common in our educational practice. They indicate face-to-face learning or online learning. Such learning is seen as a form of learning, where mutual differences in students' perceptions are used as learning potential. And therefore, face-to-face teaching or online teaching - an epoch-making dilemma?

Pronounced changes in society occur under the auspices of modern trends in which information spreads at high speed and becomes more and more complex. Mastering basic knowledge in such an environment is as important as ever, but it is no longer enough. Today's students need to learn much more than previous generations (Boud, 2001). They need to know how to find and use new information, how to make important decisions about complex issues, and how to cooperate with others. There is no doubt that different learning models change the approach to the nature of learning (Gal and Fallik, 2021), because it becomes enjoyable and useful, and its participants become more deeply involved (Gamal, 2017). Therefore, it is necessary to provide the possibility to direct the potential of direct or online learning towards the

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function of encouraging the holistic competence of students, that is, that students not only mutually build and develop holistic support by learning from each other, but also by learning from each other.

Learning is an active and dynamic process in which students learn through work and practical experiences. Establishing a dynamic learning environment requires student-centered teaching, which consists of interactive situations and encourages students to participate more during class. This approach to the educational process is recognized in pedagogical literature as interactive pedagogy (Knežević-Florić, 2006). With an interactive approach, the teacher encourages students to exchange certain knowledge and experiences with each other in order to let them know that interactive relationships are valued in teaching. In practice, it has been observed that some students learn the material most easily while listening to the teacher teach a certain lesson, others by reading contents from textbooks and recommended sources, some while transcribing lessons and making summaries, retelling the lesson, underlining certain teaching contents, extracting key words or theses, drawing mind maps, tables, graphs, etc. In accordance with different learning styles, teachers should carefully select different educational tools for learning (Kovačević, 2021).

Is interaction in the school environment a starter of both face-to-face and online learning? The nature and quality of interactions and relationships are partly determined by the acquired skills and motivation that individual students bring to their experiences. This includes the student's social skills. Some of those skills are emotion recognition and expression, decision-making and problem-solving, perspective-taking, empathy, and communication (Woods and Hanish, 2021). Each of these skills is important for interaction and relationships because it allows individuals to understand their own needs, goals, and desires, but also to understand the needs, goals, and desires of other students. It is considered that student-teacher interaction is one of the key factors in increasing student satisfaction with online teaching (Sher, 2009). Interaction with other students, as well as strong interpersonal relationships, increase students' sense of belonging to a group and are also associated with persistence in studies (Rivera Munoz et al., 2020) and achievements in the learning process (Cardoso et al., 2011).

The fact is that a large part of online learning takes place informally without the teacher's involvement in the process itself, which is characteristic of students' activities in their free time. But formal online learning that takes place in the school environment can contribute more to more effective learning among students than traditional methods of learning and teaching (Baltzersen, 2024; Ilić, 2013: 182). It should not be seen as a substitute for teaching and activities carried out by teachers, because online learning is an important supplement to teaching and learning itself that improves the quality of education and education of students. It can be organized depending on the nature and character of the teaching content, the goal of the lesson, and the needs and abilities of the students. Online teaching directs students towards this global field and provides them with the opportunity to enter the digital work market more prepared and aware. A proactive approach to this form of teaching implies not only the use of existing knowledge, but also turning to predictive research within the framework of creative thinking studies.

Unlike online teaching, classroom teaching is closer to reality, it gives students the opportunity to reflect, discuss, and debate with their colleagues and teachers. With effective teaching, the teacher encourages self-directed learning if: 1) he identifies indicators of the level and structure of knowledge, interests and needs for learning, for gaining experiences, abilities and skills, and establishes how to help the student engage those potentials in solving learning tasks in the zone of the student's immediate further development; 2) get to know the individual learning style and its limiting and encouraging characteristics; 3) determine the learning goals, identify the desired outcomes and acceptable evidence that they have been achieved and 4) together with the student, prepare, implement and evaluate two or three learning plans, getting the student used to often asking himself what he has learned (Ilić, 2013: 182). Effective teaching is a unique process of complementary educational activities of teachers (leading teaching) and cognitive-creative activities of students (learning) with the aim of acquiring knowledge, improving skills, forming positive habits, developing abilities, nurturing moral qualities and other potentials of the emancipated personality of each student to their personal maximum. The level of effectiveness of teaching is determined according to the essential features of its courses and the quality of educational outcomes or results (Ilić, 2015).

The simplest principle that underlies all the syntheses discussed above is "safe learning and teaching". It is achieved when it has an explicit and transparent purpose, when it is challenging, and when both teachers and students strive to achieve the set goal. Safe learning and teaching are achieved when there are exercises whose purpose is actually to achieve the goal, when feedback is established, when teachers and students actively and passionately participate in the process. (Andevski, 2015: 43).

Both face-to-face and online classes can be organized in different ways. Visible structures are less important if they are applied more often. A key condition is the teacher's view of his own role in the learning and teaching process, what is his influence on the student's learning. In this sense, it is necessary for teachers to apply the evaluation of their actions through the information they receive from students, which can be checked, changed, and maintained. This refers to the following aspects: What is each student, following the actions of the teacher, obliged to do? How can available resources be used to move students to the place where, according to the teacher, they should be - and in the most effective way? It is very important what the teacher does, but the most important thing is that - by what he does - he affects the students in the right way. With the appropriate spirit and appropriate actions, a positive learning effect will be achieved.

Bearing in mind that the pace of social changes shows no signs of slowing down in the future, and that it is necessary to monitor and adequately respond to changes in higher education, the goal of this research was to examine the perception of students about online and face-to-face teaching, as active users of these forms of teaching, but also key subjects who can contribute to the identification and implementation of positive changes.

Materials and Methods

Research Aim and Research Tasks

The aim of this research was to examine students' perceptions of online and face-to-face teaching by combining quantitative and qualitative research approaches. The importance of this topic stems from the fact that online teaching is increasingly present in education, especially in higher education institutions. Accordingly, it seeks to determine the current state of practice and the possibilities for its improvement. In accordance with the research objective, the following tasks have been defined:

1. Determine the orientation of students towards online or face-to-face teaching.
2. Examining students' perceptions of online and face-to-face teaching with regard to independent variables (study program and average grade during studies).
3. Examine students' opinions on the advantages and disadvantages of online teaching.
4. Explore the advantages and disadvantages of face-to-face teaching from students' perspective.

The research was based on the assumption that students would show a stronger preference for face-to-face learning compared to online learning, with differences expected in relation to the independent variables (study program and average grade during studies). It was further assumed that students would perceive more advantages than disadvantages of face-to-face teaching, while attributing more disadvantages to online teaching.

Sample

The total sample of the research includes 524 students' Faculty of Philosophy in Niš on the territory of the Republic of Serbia. The sample structure in relation to the observed variables included male (20.6%) and female (79.4%) students. Of the total number of participants, 54.2% studied in non-philological majors, and 45.8% in philological majors. When it comes to the average grade, 21.2% of students had an average between 6 and 7, 30.0% between 7 and 8, 28.1% between 8 and 9, while 20.8% of students had the highest average (between 9 and 10).Taking into account the data on the total number of students enrolled this year and the total sample of this research, the sample size fully meets the 95% confidence interval.

Research Instruments and Procedures

For the purposes of the research, an instrument was constructed that contains 15 statements and examines the preferences of online versus face-to-face teaching in terms of different segments of teaching implementation (*I am more satisfied with online teaching than face-to-face teaching; Online teaching made it easier for me to master the teaching content more than face-to-face teaching*; *Online teaching contributed to greater social interaction with teachers and colleagues than face-to-face teaching*. *My learning progress improved more during online than face-to-face teaching classes*; *I am more motivated*

to work in online classes than in non-direct classes, etc.). The students responded to the items on the scale from 1 (not at all true) to 5 (very true). The validity of the scales is .95, which is confirmed by the Cronbach α value of internal consistency.

The research also included three open-ended questions, which were asked in order to determine the orientation of students towards a certain type of teaching and their perception of the advantages and disadvantages of online and face-to-face teaching.

Students were first introduced to the purpose and tasks of the research. Considering that it is about students who are 18 years old and older, they confirmed their consent to participate in the research. Only after obtaining their consent did the students complete instrument, with the option to withdraw from participation at any time. Completing the instrument took approximately 15 minutes. Full anonymity and confidentiality of participants were ensured throughout the research process.

Data Analysis

For the purposes of this research, the arithmetic mean (M) was employed as a measure of central tendency, while the standard deviation (SD) served as an indicator of variability, showing the degree of deviation from the mean value. To identify differences between variables, an analysis of variance (ANOVA) was conducted and a t-test to examine differences between independent samples. All statistical analyses were carried out using the SPSS 25 software package.

The qualitative analysis was conducted by grouping students' responses into categories based on their similarity, followed by identifying and presenting the most representative responses in their entirety.

Results

In order to determine students' perception of online and face-to-face teaching in relation to the independent variables, t-test and the analysis of variance (ANOVA) were applied. Table 1 shows that statistically significant differences ($p<.05$) were found in students' responses in relation to the study program they attended.

Table 1. *t-test results for the difference between the students' perceptions about the online and face-to face teaching*

	Study programs	*M*	*SD*	*t*	*df*	*p*
Online teaching made it easier for me to master the teaching content more than face-to-face teaching	Non-philological	2.41	.99	-2.181	522	.030
	Philological	2.68	1.05			

**The mean difference is significant at the .05 level*

On average, philology students (M=2.68) agree more strogly with the statement that online teaching made it easier for them to master the material compared to face-to-face teaching, than non-philology students (M=2.41). Therefore, the determined statistically significant difference (t=-2.18, p=.030) in relation to the stated statement indicates that students of philology majors perceive online as opposed to face-to-face teaching as more useful for mastering the content, than students of other majors. There are no significant differences in other statements, which shows that students of all majors have similar attitudes. Table 2 shows the differences in the students' perceptions of the perception of online and face-to-face teaching relative to the average grade during studies. The results of the t-test in Table 2.

Table 2. *Students' percepcions about the online and face-to face teaching in relation to average grade during studies*

	Average grade during studies	*N*	*M*	*SD*	*F*	*df*	*p*
I am more satisfied online than face-to-face	from 6 to 7	111	2.64	1.46	2.867	3	.036
	from 7 to 8	157	2.75	1.52			
	from 8 to 9	147	2.50	1.47			
	from 9 to 10	109	2.23	1.33			

**The mean difference is significant at the .05 level*

The results in the presented table indicate the existence of a statistically significant difference between students of different success, but within only one statement "I am more satisfied with online teaching than face-to-face teaching" (F=2.867; p=.036). A post hoc test showed that there were differences between students with an average of 7-8 and 9-10, whereby students with a lower average were more satisfied with online teaching compared to students with a higher average. For the other statements, the differences were not statistically significant (p > .05), which indicates that the success of students does not significantly affect their perception of satisfaction with online compared to face-to-face teaching.

Table 3. *Student orientation towards the type of teaching*

Type of teaching	Student responses
Online teaching (25%)	- ,, I would opt for online, because we can follow it at any time and from any place. And the most important thing is that I have more time for studying and other obligations". - "Due to practicality - I don't waste time traveling to the university and back, I can sleep a little longer in case I have a morning class, I can drink coffee while listening to a lecture, I can even be in bed and listen to the lecture, and that makes me feel more relaxed." - "I save money with pdf files because I don't have to buy books". - "Because it gives me more time for pre-exam duties than direct classes, it is always available and less stressful." - ,,.I feel more relaxed during online classes, I organize my time and learning pace as suits me. For me personally, the motivation is greater during online classes." - "A more flexible schedule of classes, and the costs of studying are reduced and we have a comfortable time to work in addition to studying." - "Because lectures are not mandatory, so there is less pressure, and because of much more free time."
Direct teaching (70%)	- "Immediate, because it is more pleasant, holds attention longer and is more effective". - "Because of greater motivation, physical activity (the way to college and back), better socialization with colleagues and professors". - "Because it is more effective in terms of student activity and attention in class". - "Direct teaching because there is more interaction and my concentration is better." Mentally, I feel better when I know that I have an obligation to go somewhere during the day and not to spend the whole day in my room. I follow and learn easily and have a greater sense of responsibility" - "It's easier to follow the content, and live teaching is of better quality for knowledge acquisition and interaction". - "I will take into account that at our faculty we deal exclusively with social sciences, it is really absurd to think that social sciences can be learned online".
Combined teaching (5%)	- ,, I could not choose between these two types of teaching. Maybe some combination could be made and both methods of work applied". - "Both have advantages and disadvantages, so it is best to combine them". - ,, Organize some lectures, possibly exercises, live, and some theoretical ones online. So, combined".

In the presented table, the data show that the majority of students (as much as 70%) prefer face-to-face teaching, while fewer (25%) opt for online teaching. A very small percentage (5%) emphasizes the combined model, based on the fact that both types of teaching have their advantages and disadvantages, and that the benefits of both should be used in order to improve educational practice. Reasons in favor of the majority of students' orientation towards face-to-face teaching indicate greater student motivation for learning and work, achieving better social interaction and higher quality teaching. We should not ignore the answers that confirm the importance of online teaching, especially its flexibility in terms of organization, available time, and comfort while attending classes.

Table 4. *Advantages of online classes from the students' point of view*

Categories	Student responses
Spatial flexibility	- "I don't have to get up early and go to class, I follow it from home." - "The big advantage of online classes is that you don't have to put in physical effort to attend classes and it's more relaxed in general because we're in a space that suits us." - "Online teaching is easier for students who do not live in Nis, the classroom is our room, so the comfort is greater.
Better time management	- ,,I can organize my own time, which refers to how much I will devote to each subject per day. It saves time and money." .- "Easy distribution of time and organization of all the obligations we have during studies." - "Easier organization of time if we have private obligations."
Psychological benefits	- "We can follow the lectures in a relaxed way, without any stress." - "Less nervousness and tension." - "Less anxiety due to the absence of a large number of people in one room." - "Personally, I have less nervousness".
Organization and quality of the teaching process	- "We have more time to study and prepare pre-exam assignments." - "Greater availability of learning materials and the possibility of completing several academic duties at the same time." - ,, Existence of diverse and effective methods for processing and adopting materials. And the good thing is that lectures and exercises can be recorded." - "Individual work is present. Everyone can work at their own pace and according to their own capabilities."
Digital literacy	-,,Online classes helped me develop digital skills." -,,We improved the knowledge needed to follow online classes and learned some programs for presentations." -,,I learned to use different programs that mean something to me outside of class as well."

The responses of students shown in Table 4 indicate that online teaching provides spatial flexibility, better organization of time, that it has psychological benefits, positive elements that include the organization and quality of the teaching process, as well as that it encourages digital literacy. Students stated that the online format allows them greater freedom to choose the place and time of study, better coordination of obligations and saving time. It was also pointed out that this way of working reduces stress and anxiety, and creates a more relaxed atmosphere for learning. As additional advantages, students recognized the availability of teaching materials, greater independence in work and the development of digital skills, which are also useful outside the academic context. The mentioned advantages confirm that online teaching contributes to greater flexibility and empowering students for modern and self-directed learning.

Table 5. *Weaknesses of online teaching from the perspective of students*

Categories	Student responses
Lack of social interaction with professors and colleagues	- "Insufficiently high degree of possibility of achieving adequate communication with professors and colleagues, because it is mostly one-sided." - "Given that the cameras are mostly turned off, there is no non-verbal communication." When someone says something, he usually doesn't get any feedback from his colleagues, and sometimes not even from the professor, so it's extremely difficult to interact." - "The interaction between colleagues and between students and professors is impoverished." I believe that virtual communication for educational purposes cannot meet the high level of productivity precisely because of this, in contrast to live teaching." -,,I believe that online teaching largely isolates both students and professors and in some way retards the skills of communication and connecting with people (and socialization, in addition to acquiring academic knowledge and skills, is still an integral part of education and life)."
Lack of motivation and concentration	- "Students lose motivation and become lazy." - "Online classes demotivate me." I notice that others also get lazy because they are "lulled." - "We have no concentration, no attention, and no will to sit alone at home and listen to classes." - "Online teaching is boring and monotonous and does not in any way contribute to motivation and energy when it comes to studying." - "I think the biggest punishment is to lock young people in a room and give them a computer." My motivation is at zero. It's hard for me to study and finish all my duties because I don't see the point of this kind of work."
Didactic-methodical weaknesses	- "With online teaching, much less knowledge is gained because the professors are also more lenient, and this is to the detriment of our knowledge." - "The material is more difficult to master because a lot of independent work is required of us." - "The courses themselves are not designed for online teaching" - "Less time for online tests due to professors' fear of copying" - "Online colloquiums do not show students' real knowledge" - "Professors burden us with pre-exam obligations that are not sufficiently valued" - "The impossibility of organizing joint work in groups and workshops" - "Professors do not adequately prepare for teaching"
Organizational weaknesses	- "It happened that professors don't know how to organize themselves, so they are late for classes or change the dates of lectures." - "Some professors did not send work materials on time" - "A large number of students do not listen to lectures because they are not compulsory" - "There is too little time for tests and assignments in online classes"
Technical problems	- ,,Poor conditions for following online classes. Some students may not have equipment to listen to online classes, or share a laptop/computer with another family member. It also happened that some students did not have access to the Internet or their Internet connection was bad." - "Due to numerous technical problems, it may be difficult to follow the lessons, and the few who do not have the technical conditions cannot keep up with the information regarding teaching and learning."

One of the key weaknesses of online teaching, according to students, is the lack of adequate communication and interaction with professors and colleagues. This form of teaching, according to the respondents, makes it difficult to establish quality relationships and mutual connections between the participants of the teaching process. Students also pointed out that online teaching does not provide sufficient incentive for learning, which, among other things, can be linked to insufficient motivation, but also to shortcomings in the organization and technical conditions of its implementation. A significant number of responses indicate the poor quality of teaching preparation and implementation, which points to the need for its further improvement.

Table 6. *Students.s responses on the benefits of face-to-face teaching*

Categories	Student responses
Pedagogical communication	- "I will never forget all the lessons I learned from my professors." I learned from them that the pedagogical approach and how to communicate with others is very important." - "When I talk live with colleagues and professors, I can see their reactions and then I can judge whether I did well or not, because those non-verbal signs cannot be seen when we have distance learning. - "Nothing can replace live contact with professors and colleagues." We can get to know each other better and build a relationship of trust and respect." - "The best cooperation is achieved live, because that's how we communicate two-way and we respect each other more and socialize."
Pedagogical climate	- "The advantage of direct teaching is that I feel beautiful and fulfilled in classes." - "At our university, everyone tries to create a nice atmosphere so that the students enjoy and learn." - "Live teaching contributed to me socializing more with my colleagues, because the professors put us in a position where we have to interact with each other." Then friendships develop and somehow we bond better." - "It means a lot to me that I can have a good relationship with everyone. There are few of us in the course and it makes it difficult for us to study if we don't have a good relationship and if we don't help each other."
Didactic-methodical aspect of teaching	- "We often work in a group during classes and learn from each other that way." We are never bored because the professors apply different work methods." - "Colloquiums and exams are much more difficult to take live, but that is actually an advantage of face-to-face teaching." Not everyone can pass and professors have higher criteria for passing." - "It requires active participation, full attention and concentration." - "Learning is much easier because I can ask the professors anything and they immediately explain the material to me." - "Professors design the class in such a way that they put us in a situation where we have to think, connect and critically analyze what we learn." - "Professors can explain the grade to us, monitor our work and give us the opportunity to assess for ourselves how much we know and how much we don't." - "Direct teaching is of high quality, because it is based on mutual discussion between professors and students, and therefore we can open up various questions and dilemmas." And it's also much more interesting, because the way of working is somehow more creative.
Developing social-emotional competencies	- "Live in some subjects we learn how to express emotions, which is very important for us as individuals and professionals." - "In the classes, we develop empathy and come to a conflict of opinion with each other, this helps us for life and the profession I have chosen for." Tomorrow I will have such situations in practice, so it is important that I have those skills." - "Our professors and teaching assistants emphasize that we show tolerance, because we are all different and come from different families and backgrounds." - "Live teaching is good because it gives us the feeling that we are important to others, that I can rely on my colleague, understand him better and share some problems with him, and he listens to me and helps me overcome them."

Given that the research results showed that students prefer face-to-face teaching, the answers shown in Table 5 confirm a number of significant advantages of this type of work. Among them, the following categories stand out: pedagogical communication, pedagogical climate, didactic-methodical aspect of teaching and development of social-emotional competences. Students especially emphasize the importance of direct contact with professors and colleagues, and emphasize the importance of an open, quality and supportive relationship, based on cooperation, mutual respect, trust and a pleasant atmosphere that encourages learning and work. In addition, the respondents believe that it is extremely important that teaching be diverse in terms of methods and forms of work, as well as that the teacher provides continuous support to students in mastering the teaching content, monitoring progress and evaluating their achievement. Students especially emphasize the importance of developing social-emotional competencies, which they consider important for their future professional roles, which represents another significant advantage of face-to-face teaching classes.

Table 7. *Students' answers about the weaknesses of direct instruction*

Categories	Student responses
Organizational and economic weaknesses of direct teaching	- "It bothers me that I have to print books, and now everything is online and I don't understand what we would do when the professors can send them to us in pdf format." - "Well, the weakness is that I'm from another city and I have to either rent an apartment or travel every day to the university." - ,,.Mostly, we have lectures and exercises every day, sometimes for the whole day. When it's like that, I have to buy something to eat, and sometimes I sit down for a drink with my colleagues. I need money for all that, so maybe that's a weakness"
Lack of flexibility and free time	- "It is more difficult for me to organize myself and coordinate all my obligations, because it takes a lot of time for me to go to college, follow lectures and exercises, and the fact that we have breaks, so I waste that time, and if I were at home I could use it to finish pre-exams or to study or for private things." - "The weakness is that sometimes I come for a consultation, but I can't find the professor, so I wait for him and waste my time." - "Exams sometimes take a long time and I can't use that time for anything, I have to wait for them to call me to answer." - "Because I'm often at university, I don't have much free time for other activities and seeing friends."

Although students mostly emphasized the advantages of direct teaching, some of them also pointed to its disadvantages, which primarily relate to economic unprofitability and limitations in terms of time and organization of obligations. Namely, the students stated that this type of teaching requires higher financial allocations, both for printing teaching materials and for the daily expenses of staying at the university (food, transportation, accommodation). In addition, the problem of less flexibility in the schedule of duties was highlighted, given that physical attendance at classes and breaks between classes take a significant amount of time, which, according to the students, could be used for exam preparation or private activities. Also, some students mentioned situations in which there is an unplanned loss of time, such as waiting for consultations or longer exam dates.

Discussions

One of the results of this research confirms statistically significant differences in the perception of students of philology and non-philology majors. More precisely, it was determined that students of philology majors perceive online teaching as more useful for mastering the content than students of other majors. Similar findings were recorded in other studies (Mohamed et al., 2023; Johnson and Palmer, 2015), which indicate that this perception of students results from the greater availability of teaching materials that enable repeated learning, as well as from the fact that this form of teaching is particularly useful in mastering theoretical content. However, we should not ignore the findings of other research (Siddiqui et al., 2024; Photopoulos et al., 2022), which indicate that students of philology majors prefer non-direct teaching to a greater extent because of its practical character, i.e. the possibility of active language practice and direct interaction with others. Therefore, the nature of the teaching content greatly contributes to the students' perception of the usefulness of online teaching. According to the above, it can be concluded that unlike non-direct teaching, which is irreplaceable in terms of developing communication skills, online teaching is more suitable for the acquisition of theoretical content and independent learning.

The research also confirmed the assumption about the existence of differences in the perception of online and face-to-face teaching of students in relation to their academic success. Although the difference exists only in terms of satisfaction with online teaching, the result is significant because it indicates that students with a lower average were more satisfied with it compared to students with a higher average. Mohamed et al. (2023) obtained the same results, which may indicate that academically successful students have higher expectations and a more critical attitude towards online classes, while students with a lower average can be said to take different elements that meet their criteria.

On the other hand, the answers of the students confirm that 70% of them prefer face-to-face teaching, 25% opt for online teaching, and only 5% of students highlight the combined model, which, in their opinion, would contribute the most to the quality of teaching. Authors Adnan and Anwar (2020) surveyed students and found out that there is a reservation of students towards online learning. As many as 71.4%

of students stated that traditional learning was more effective compared to online learning. One of the reasons for such results may be that face-to-face teaching enables more active and effective learning than online teaching.

When it comes to the advantages and disadvantages of online teaching, significant qualitative results were obtained that confirm the initial assumptions and are in line with the quantitative indicators. Regarding the advantages of the separate category (spatial flexibility, better organization of time, psychological benefits, positive elements of organization and quality of the teaching process and encouraging digital literacy), they point to different, but also interconnected aspects. The perception of the effectiveness of online teaching depends not only on organizational factors, but also on the psychological adaptation and emotional experience of students in the digital environment. Students recognize the potential of online teaching, which relates to the improvement of the structure and quality of the educational process, and emphasize the importance of digital literacy, which is the basis for the application of online teaching and its further improvement. Another research confirmed that online teaching enables active and flexible learning and fosters an individual approach. The observed advantages are in accordance with the findings of this research, and concern flexibility, cost-effectiveness, time efficiency and the possibility of applying innovative learning methods (Govender and Matlhaba, 2024). As the results of other research confirm that self-motivation, the ability to understand e-learning, as well as training students for independent work are very important for online teaching (Jevtić, Milošević and Jevtić-Trifunović, 2022; Bismala and Manurung, 2021), it is evident that many of them are still not prepared for this type of work. Bearing in mind that the quality of teaching is greatly influenced by the teacher, the need to redefine his role in accordance with modern needs and conveniences that this model provides is recognized. One of the ways of adequate preparation for such challenges is to implement programs with future teachers that aim to develop pedagogical and professional competencies through structured mentoring, which also contributes to their professional performance and the success of students (Yespolova et al., 2025).

The students' answers about the weaknesses of online teaching are classified within the categories related to the lack of social interaction, insufficient cognitive and emotional engagement during the learning process, low level of didactic-methodical preparation and realization of teaching and organizational and technical difficulties in the implementation of this type of teaching. There is no doubt that students emphasize the disadvantages of online teaching more than the advantages, which indicates that the online form of teaching has not yet reached the desired quality in order to support the academic, social, emotional and other needs of students. The research conducted by Adnan and Anwar (2020) also confirms the weak reach of the Internet, which made it difficult to conduct online classes, but also the lack of social interaction with colleagues and the application of interactive methods and forms of learning in a digital environment. The same results were reached by research conducted in Serbia on a sample of students, which confirmed the results obtained in this research and which indicated the need for innovation in online teaching, especially in the segments of presentation of teaching content (Arsenijević et al., 2022). It is equally important to mention that one of the key disadvantages of online teaching is the impossibility of conducting practical teaching (Kulal and Nayak, 2020; Nambiar, 2020), which was also confirmed by this research.

Bearing in mind that students emphasized the advantages (pedagogical communication, pedagogical climate, didactic-methodical teaching quality and development of social-emotional competences) much more than the shortcomings of face-to-face teaching (economic unprofitability and limitations in terms of time and organization of duties), it can be seen that the shortcomings of face-to-face teaching are actually the advantages that students have stated for online teaching. This result confirms once again that direct teaching is the best way for students to achieve mutual relations with professors and colleagues, to acquire adequate theoretical and practical knowledge supported by active ways of working and continuous support of teachers, but also to develop socio-emotional competences, which they consider crucial for their professional vocation. Recent research confirms the importance of social interaction and cognitive skills. More precisely, from emotional support and interactive relationship with others, motivation for learning and student achievement increase (Karpovets et al., 2025). Therefore, open communication and a supportive atmosphere are essential for a quality relationship and the realization of online teaching (Almossa, 2021). From the attached, it can be concluded that in teaching practice, it is extremely important to combine these two types of teaching, because they mutually contribute to different aspects that affect the quality of teaching and studying.

Given that a limitation of this study was focusing solely on student perceptions, without including all

segments of online and face-to-face instruction, examining teachers' perceptions and comparing them to student perceptions could provide significant insights for future research.

Conclusions

The results of this research confirm the differences in students' perceptions in certain aspects of online and face-to-face teaching in relation to the study program they attend and the academic success they achieve within their study programs. The orientation of students towards direct teaching stems from the advantages they attribute to it, primarily in terms of quality pedagogical approach, stimulating pedagogical atmosphere and opportunities for the development of socio-emotional competences.

Although students also recognize certain advantages of online teaching, such as spatial flexibility, better organization of time, psychological benefits and the development of digital literacy, their opinions nevertheless point to more pronounced challenges of this type of work, which are reflected in reduced social interaction, weaker engagement and the present organizational and technical difficulties. Despite this, the potential of online teaching remains an important resource for improving modern teaching practice and adapting it to the needs of students in the digital age.

Taking into account that both types of teaching have their advantages and disadvantages and that, according to the students' perception, it is first of all necessary to raise the quality of online teaching, the need for complementary consideration and application of both models in higher education practice is recognized. In order for online teaching to take root in higher education institutions, it is necessary to provide not only technical conditions for its implementation, but also other segments related to the teaching process and cooperation with students. It is especially important to cultivate a positive attitude towards this form of teaching, to develop and continuously improve the competences of teachers and students, as well as to devise ways to satisfy the emotional and social needs of students. In addition, it is particularly important to ensure the pedagogical conditions necessary for quality online teaching, which include thoughtful planning of teaching activities, application of methods and strategies that actively involve students, adaptation of content to different learning styles, as well as continuous training of teachers for the application of innovative tools in online teaching. A high-quality pedagogical approach allows the teaching to be not only informative, but also motivating, interactive and directed towards the development of students' intellectual, emotional and social competences. Such an approach not only ensures the quality of education, but also enables the holistic development of students as future bearers of social progress.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The data collected and analyzed during the research are fully included in the published article. Necessary details, clarifications, or data supporting the findings of this study are available from the corresponding author upon request. For further information on data availability and journal policies, please refer to the official IJCRSEE guidelines.

Institutional Review Board Statement

The study did not involve procedures requiring formal approval from an institutional review board

(IRB) or ethics committee, as it relied solely on voluntary, anonymous participation in full compliance with ethical standards. Prior to participation, informed consent was obtained from all participants. Participants were informed of the study's objectives, procedures, potential risks, and benefits, as well as their right to withdraw at any stage without any negative consequences. All ethical considerations were observed, including the confidentiality of personal information, voluntary participation, and data protection in accordance with applicable legal and institutional guidelines.

Author Contributions

Conceptualization, D.M.; data curation, D.M. and N.T.; methodology, D.M. and J.M.; resources, D.M. and J.M.; formal analysis, D.M., J.M.; validation, D.M., J.M. and N.T.; writing—original draft preparation, D.M., J.M. and N.T.; writing—review and editing, D.M., and J.M. All authors have read and agreed to the published version of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Higher Education Management Systems in Iraq: Problems and Perspectives

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Abstract: Iraq is a country that has not only rich centuries-old history and antique culture, but also the oldest in the world education system combining old and new cultural and ethnic particularities. Islamic traditions and religious syncretism – all of these must be known to those who plan to receive education in this ancient and very important country of the Islamic world. This research is intended to fill a gap in intercultural and interfaith dialogue in the context of international scientific and educational cooperation Although the Iraqi higher education system shows the example of one in the country with an unstable political situation, it is represented not only by national educational institutions, but it is becoming a modern hierarchical structure that meets the needs of modern time, directly related to the growth and development of the nation. The purpose of the research is to analyze the Iraqi higher education management system within the world education market today, and to offer recommendations of how to improve current situation with implemented innovations and managerial decision-making methods. In the article we deal with the threefold methodology: the first part is the Iraqi higher education system analysis with insights into effective and efficient managerial practices to comply with contemporary challenges; the second part is modern managerial decision-making methods, such as the Kepner- Tregoe, consideration to implement in education for future improvement. Analytic Hierarchy Process (AHP) decision-making methods are supposed to significantly improve the Iraqi higher education management effectiveness; the third part is international student and teacher exchange, collaboration with famous Universities in Europe and Asia, joint scientific projects that play a crucial role in enhancing the quality and competitiveness of Iraqi higher education. The results of the research will help educational institutions formulate more effective management strategies, avoid risks, apply optimized organizational strategies and tactics, predict modern educational traits and trends, make use of advantageous measures, formulate cooperation and competition strategies, and improve innovation capabilities. In the conclusion recommendations were made how to boost institutional performance and make the complex academic processes streamlined and impactful for students and institutions.

Keywords: *Iraqi higher education, management strategies, Kepner-Tregoe, comparative analysis, Analytic Hierarchy Process (AHP), digitalization, decision-making.*

Introduction

The development of an educational system that meets the need of modern times directly relates to the growth of a nation. Education extends beyond the mere addition of vocabulary to one's thesaurus; it shapes personality, thoughts, and social skill, if and when delivered properly.

Iraq (also called Mesopotamia: the land between two rivers) was known as the cradle of civilization, the place where the first letter was written and complex urban centres grew. School education was supposed to develop children's creativity, critical thinking and analyzing ability through formal education much

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similar to global models. Still standing in Baghdad the original Mustansiriyah school, established in 1227 by Abbasid Caliph Al-Mustansir, was indeed a significant and ancient scholarly institution; Islamic law, mathematics and medicine were taught there. It is considered one of the earliest world's universities, and while its building was damaged during 1258 Mongol siege, it still stands and is now under the restoration.

The Iraqi society in 1958 was very much affected by the political and social awareness, which in turn was focused on the significance of mandatory education. During the 1960s, Iraq invested heavily in education, establishing new higher education institutions in major cities like Baghdad, Basra, Mosul, and Al-Sulaimaniyan while also providing Iraqi students with scholarship and grant opportunities to study in Western Europe and North America. This period was characterized by growing government spending on education and a focus on making mandatory education a priority. Also the government increased its spending on technological innovations in education.

Education in Iraq was free by the law, and in 1974 private education was completely abolished. The control of the government on the educational sector kept growing as more laws were issued, until the year 1987, allowing the government overseeing over pre-school institutions and compilation of educational policies and strategies of further development. By 1985, Iraq was free from illiteracy. In 1984 federal expenditure on education was only 6% of Gross National Product (GNP) and the average federal spending per student came up to $620.

The gulf war, the consequential sanctions on Iraq, and the UN Oil-for-Food-Programme (OFFP) in 1995, caused the expenditure on the educational sector greatly. The Program increased educational spending reaching $6,000 per student, as it was intended to help Iraqi civilians affected by sanctions allowing them trade oil for humanitarian goods, not to reduce spending on education. The resources obtained from the OFFP barely covered the social sectors that included health, water, and sanitation, with the education sector having the lowest share. Teaching staff's salaries dropped significantly as the program did not cover it. This caused large-scale teacher Exodus: some of them changing profession, others looking for a job abroad. Starting from 2023, when education became one of the most affected sectors, the government considered education reform a major task in the rebuilding of Iraq.

Today in Iraq, all citizens have right to free education, primary education level is mandatory, and eradication of illiteracy as stated in Article 34 of the constitution of 2005. The Ministry of Education runs a strongly centralized national system according to the principle of centralization of planning and decentralization of implementation. In 2016, Iraq spent 6.8 trillion IQD (around $ 5.7 billion) on education for central Iraq, a 44.2% increase from 4.7 trillion IQD in 2010-2011. Iraqi federal government spends approximately 1.3 million IQD (around 1,000 USD) per student annually, covering all levels of education from pre-school to upper-secondary education, though infrastructure remains a major challenge. The majority of the education budget goes to salaries and operational expenses, with little left for other vital non-salary operational costs. While the per-student spending is a significant amount, overall government spending on education decreased from 7.9 trillion IQD in 2012-2014 to 6.7 trillion IQD in 2015-2016.

There are two ministries in Iraq that are responsible for the education development and management. The Ministry of Education (MoE) supervises preschools, elementary and secondary schools as well as centres for professional training and retaining, while the Ministry of Higher Education and Scientific Research (MOHESR) is responsible for post-secondary education institutions functioning, encompassing technical colleges and research facilities performance to comply with the federal governance. The Ministry of Higher Education and Scientific Research (HEM Report, 2020) aims at making qualitative and quantitative changes in scientific, technical, informational, technological and cultural development in the country.

COVID-19 was the stop button for normal daily activities and education was one of the first sectors to halt all activities, albeit it had to continue regardless of the COVID-19 situation. The first means of remote education was introduced to students by the government in 2003 via a governmental TV channel, with the aid from UNESCO, dedicated to broadcasting the curriculum to students.

In the face of the COVID crisis, the Ministry of Education in Iraq was set with digital platforms available for students and educators to use. Google Classroom is one of the most commonly used across Iraq. Newton (The MoE online platform) was developed by the federal government. Courses are taught in Arabic for internally displaced and refugee learners in contexts where it serves as a primary language for particular regions, such as within the parallel education systems established for Syrian refugees in the Kurdistan region of Iraq. Some organizations also offer Arabic language instruction to support refugees

and displaced people from various countries, helping them earn income and connect with others.

Iraq, formerly Mesopotamia, is a birthplace of the world civilization, with rich ancient culture and the origins of writing, law and the wheel, the formal schooling developed later in the history. Although Iraqi education today faces a lot of challenges from political and religious conflicts and federal underfunding, its ancient heritage is profound. Iraqi cultural and ethnic particularities, religious syncretism – all of these must be known to those who plan to receive higher education in this ancient and very important country of the Islamic world. This research is intended to fill a gap in intercultural and interfaith dialogue in the context of international scientific and educational cooperation.

In Iraqi scientific circles research into the higher education management systems was carried out, highlighting the problems and outlining development and innovation prospects for the Iraqi education. Authors to be mentioned are Sabah Faihan Mahmud (Sabah, 2013), Ezzadin N. M. Amin Baban (Baban and Rashid, 2017) , Salam J. Bash Al-Maliki (Al-Maliky, 2012), Govand H. Sherwani (Sherwani, 2018), Mukdad A. Al-Khateeb , Nadhir Al-Ansari, Sven Knutsson (Al-Khateeb, Al-Ansari, Knutsson, 2014), Fahmy Abdullah & Shler Salih (Fahmy and Shler, 2022), Jinan Hatem Issa, Hazri Jamil (Jinan and Hazri, 2010), etc.

Numerous international scholars have extensively studied Iraq's higher education management, its evolution, and developmental trajectories: A.A. Ghatta, & M. Voronova (Ghatta and Voronova, 2016), Sufyan Al-Janabi, & David Anderson(Al-Jaberi and Anderson, 2011), S. Marginson (Marginson, 2016), V. Diwakar (Diwakar, 2015), A. Johnson, P. Hoba (Johnson and Hoba, 2015), etc..

The purpose of the research. Analyzing the Iraqi higher education current situation, its challenges, problems and perspectives within the world's market should help improving higher education management system with implemented modern managerial decision-making methods.

Hypothesis 1. Analyzing the Iraqi higher education systems could reveal valuable insights into effective management practices in order to identify common challenges and problems and also to find solutions of the issues pinpointed.

Hypothesis 2. Modern management techniques such as the Kepner-Tregoe (KT) method and Analytic Hierarchy Process (AHP) implementation provides a structured approach for prioritizing objectives and evaluating alternatives by analyzing strengths and weaknesses, while AHP uses a hierarchical framework to prioritize criteria and make complex decisions through paired comparisons. These methods being based on systematic data provides more informed and objective decision-making in any sector, high education area in particular.

Hypothesis 3: Staff and student mobility assist national higher education system through the other countries positive experiences in the field of higher education. War, corruption, and a dysfunctional regulatory environment have further exacerbated these issues, leading to administrative inefficiencies, inadequate research facilities, and education quality decrease. This analysis will also allow developing recommendations and find countermeasures for educational institutions to comply with navigating transformation and mastering evolving dynamics of higher education management, emphasizing the ongoing process of adjusting organizational strategies in order to meet the multifaceted and fluid demands of the labor market and to cause changes in Iraqi modern higher education landscape (Makarova, Makarova and Egorova, 2021).

International collaboration is vital for Iraqi higher education system by helping to address management challenges like lack of funding, outdated infrastructure, and insufficient staff training, which can be mitigated by adopting successful models from other countries. Key challenges identified are poor data management, federal interference, lack of transparency, and overemphasis on quantity rather than quality. Analyzing management system can pinpoint problems, challenges and specific issues that can then be solved by learning from international best practices.

Materials and Methods

Modern societal needs are transforming higher education through globalization and modernization, which demands that institutions adapt their functions, structures and ideologies to remain relevant and effectively serve as engines of cultural and scientific advancement. This evolution is shaped by increasing information access, technological innovations, and the need for highly skilled human resources in knowledge-based economies. Higher education serves as a main source of cultural and scientific evolution, playing a crucial role in shaping new socio-cultural realities and addressing global challenges. Key

factors addressing these innovations are rapid high-tech breakthroughs, spending limitations, and shifting student expectations, necessitating a continuous transformation within educational systems to meet new demands for innovation, critical thinking, and adaptability in a rapidly changing world (Gilmeeva, 2010; Gorshkov, 2015; Prokofieva et al., 2018; Davoudi et al., 2018; Fartash et al., 2018; Vuong et al., 2024).

The provided research describes education as a dynamic system that adapts to societal needs and shifts, makes contributions to human capital development, and drives a nation's future prosperity and advancement in different sectors. We assume that societal challenges influence education, while education also shapes society by fostering critical thinking, problem-solving, hard and soft skills, thereby increasing citizens' vitality and adaptability in situations of political instability and economic crises. Management systems in higher education vary across the world, with each country adopting its own unique approach. "Strategies toward a world-class higher education system: What patterns can Iraq follow in order to comply with international education requirements?" In the USA, for example, they deal with a decentralized system of higher education, with institutions enjoying significant autonomy. In contrast, in France and Germany, there is a more centralized approach to higher education management, with the significant role government in supporting equal rights of all citizens to receive education.

In the **Russian system of higher education** there is a significant influence of state educational policy with increasing autonomy of leading and prominent Universities, private educational institutions that appeared en mass in the 1990s constitute just a very small percentage of the sector now (Selezneva, Abakumova, and Sotnikov, 2024). Although a promising tendency to change from completely controlled by the federal government to a system of public administration is underway. Universities are hierarchically organized: with Moscow State University named after M. Lomonosov at the top, flagship academic universities, national research universities following in the wake, specialized educational institutions under federal and regional jurisdiction and financial support closing the list, with a small number of private colleges and universities going on a parallel course. Although the university-business collaboration is successfully productive, especially in the fields of information technology and petro chemistry, there is still a giant gap to be bridged in the interaction between the labour market and higher education outcomes.

There are several levels of degrees; some of them coinciding with the international standards, like Bachelor's degree, Master's degree and a Doctoral degree, some are different like a specialist degree (reserved for specific fields like medicine, pharmacy, linguistics, engineering and musical), that has no direct international equivalent and used to be the only degree for all fields in Russia until 2011 (Belikov, 2010; Dzhurinsky, 2011). Russia's abandonment of the Bologna system while maintaining standard degree levels to align with international systems and labour markets, national traditions are also preserved. The stated goal of adapting to a global job market and maintaining national traditions in the field of education are consistent with the country's stated intent.

In French education system, f major feature is the high employment probability fostered by a strong partnership between education and production enforced by a number of student grants and internships.

In contrast, the **Swiss** education system is not centralized and is divided into academic and applied tracks, the latter following vocational teaching and learning (Levina et al., 2018).

Iraq, however, faces a unique set of challenges. Higher education governance is managed through various models that are shaped by a country's history, culture, religion, economics, and politics. These models differ in their degree of state control, ranging from more centralized to more liberal, decentralized, and collaborative systems. Key elements on one side of the scale are excessive political supervision, financial instability and inequality, with student and employer expectations, and the need to maintain quality and global competitiveness on the other side of the scale. National history, traditions, cultural norms, and religious past can impact on its educational values and, by extension, its administrative structures and management style. In order to comply with the global educational requirements and to meet world's job market needs, quality and continuous improvement of education management styles are needed, often involving international accreditation and benchmarking against global standards.

Administrative models (Fig.1) must adapt to changing expectations from students, employers, and other stakeholders to remain relevant and effective. A country's higher educational management is under the influence of some political and economic problems, including financial constraints and funding cuts, religious conflicts and national intolerance (Kusargasheva, Muromtseva and Sabitova, 2013).

Figure 1. University Administrative Models of the world

Models and Processes of Educational Policy. Higher education management involves the organization, administration, and governance of educational institutions, heavily influenced by national educational policies. Various nations design and develop higher education management models so differently, as education reflects economic contexts, political trends and cultural heritage of the country (Kok, Douglas and McClelland, 2008).

Management Models are chiefly related to **Western countries,** particularly the **United States.** Managerial based model, although containing similarities to bureaucratic structures, differs in its increased focus on managing. Its implementation includes many economy techniques that private sector possesses triple-helix while aiming at performance targets, focusing on education quality, curricula conformity, managing staff (Deem, 2006) and controlling budgets(Deem and Brehony, 2005). Its central application is on meeting standards of university administration (Denman, 2005; Grey, Knights and Willmott, 2021) and organisation advocating management control (Lawler and Hearn, 1995) and devolved authority from academics to managers. Acceptance of the model affirmed appropriate spending and allowances ensuring not only cost-effective operation but financial survival. Undeniably while the model (Holman, 2000) promotes satisfying performance quotas and budgets its application conflicts with welfares' notions of education further restricting academic independence.

Bureaucratic Models. European bureaucratic structures (Germany and France, for instance) place particular emphasis on paperwork and regulative controls aiming to create conformity through standardised red-tape (Kreitner, 2012). This model is increasingly being assimilated into the broadening academic job description and workload. Its application demarcates clear lines of responsibility highlighting accountability and identifying individual culpability. The model avers 'seniority' (Jamali, 2005) and the 'chains of command' (Liu and Dubinsky, 2000) providing a structured management hierarchy (Middlehurst, 2004). While efficiency and effectiveness are strengthened through the use of standardized frameworks and corporate accountability, the paperwork flow and overemphasis on 'choosing the right answer by ticking the box' instead of giving a complete answer deteriorate thinking ability of students, detracting from required quality of collegial management and causing devolution to administrative supervision.

Collegial-Based Models are commonly found in Western countries such as the United States, Canada, and the United Kingdom, Nordic countries, Australia and New Zealand, South Africa .Collegial management structures are akin to those existing in the Ancient Universities of "Oxbridge" (Ackroyd and Ackroyd, 1999). These structures consist of a community of scholars (Ackroyd, Kirkpatrick, and Walker, 2007) and promote academic autonomy (Barnett, 1993) allowing for flexibility in debate, discussion (Fear and Doberneck, 2004), learning and teaching (Peters, 1992). Collegial management is under administrative supervision focusing on education quality rather than on performance criteria and benchmarks. Universities practising such structures value "scholarly engagement, shared governance and decision making, and rationality" (Kezar and Eckel, 2002) avoiding the more rigid and strict models that emphasise management and administration.

The Political Organisation Pattern exists through negotiation and debate at lower levels within the university hierarchy to reach consensus. The results of such discussions are then communicated to upper management for ratification or application .While the structure promotes contemplation and de- liberation and to some degree allows for freedoms of inquiry and suggestion, final authority still rests with upper management. This organisational pattern builds on Bergquist's work of the negotiation culture that establishes "equitable and egalitarian policies and procedures, valuing confrontation, interest groups, mediation, and power" existent in university archetypal cultures.

The Discipline Based Model focuses university management on ensuring particular importance to researching and teaching. The approach essentially aims to focus management towards more scholarly activities embracing more traditional notions of university management, steering clear of commercial and managerial inclinations (Gibbons, 2005). The model promotes a drive for quality and excellence in teaching and research with other considerations seen as secondary and less pertinent.

The Organised Anarchy approach to university management stems from M.D. Cohen's model of the garbage can model of management (Cohen, March and Olsen, 1972). Typical for this model is chaotic decision—making process and random interaction of challenges, choices, solutions and participants. Garbage can management model is strategic management that helps analyzing internal and external landscapes, creating strategies to achieve setting long-term goals and to forecast desirable outcomes in the future. With these model application long-term success and a competitive advantage can be achieved. Although the whole model seems unstable, unstructured and unpredictable, the elements of the model are complicatedly intermingled and intermeshed in such a way that the decision-making procedure finally takes place.

The Processes of Education Policy. Education policy is a major aspect of any education system directed at improving citizens' economic prosperity and their social status. The Policy should be aimed at shaping every citizen's individual learning experiences as the global priority for the government, thus providing the nation's human capital, financial stability, employment for everyone, and overall prosperity of the nation. Although these aspects are equally significant in every country, understanding of their formation, drivers, and impact on educational institutions and this policy environment remain underdeveloped. Education policy applies decision-making tools such as human capital theory, social justice, and financial accountability influencing its design and implementation (Vesić, Laković and Vesić, 2023).

Education policy itself is a set of theories, principles, guidelines, laws, and strategies formulated by federal or local educational authorities to regulate and guide the education system development and functioning within a specific educational landscape. These policies aim to achieve goals like customer satisfaction, product production and service performance. These quality objectives, established by top management, are often made SMART (Specific, Measurable, Achievable, Realistic, and Time-bound). To improve education management, the government of the country should clearly communicate its position and ideas about education and then support initiatives at all levels of organization, in this case the management system's quality can be accessed and the equity in education can be achieved. This involves implementing clear objectives, identifying major stakeholders and underlining their needs, providing employee professional training and engagement, and streamlining documentation processes.

Education policies are heterogeneous and diverse depending on the country and its government's goals, but in any case they should emphasise the country's citizens' civil rights, equality in education accessibility and inclusive education for people with disabilities. These policies should necessarily include teacher pre-service and in-service training as a part of professional up-grading, strong community involvement, and active family-school interaction to address the achievement gap and promote diversity. Their aim is to ensure all students, regardless of ability, have equal access to quality education, along with developing global competence and citizenship skills.

Policies also emphasize research, innovation, and flexible learning pathways, accommodating diverse learning styles and career aspirations.

The **educational policy development procedure** involves agenda setting, policy creation (design), adoption, and implementation, often followed by evaluation. The stages move from identifying issues and getting them on the agenda to creating solutions, formalizing them through adoption, and then putting them into practice through implementation and evaluation. This process typically includes several key stages:

1. Agenda Setting involves education system issues and challenges identification. Also this stage implies policy intervention in specific areas.

2. Policy Design. During this stage, involvement of educators, executives, parents, and experts is considered, and input from various perspectives to ensure a comprehensive policy is predicted.
3. Policy Adoption and Approbation. At this stage reviewing and revising policy proposals based on feedback, presenting the policy to decision makers, such as government officials, legislators, or a school board, seeking approval and endorsement of the policy by relevant authorities and seeking approval and endorsement of the policy by relevant authorities are included.
4. Policy Implementation. During this stage, educators and administrators are trained to ensure successful implementation. Also monitoring and adjusting implementation strategies are needed.
5. Monitoring and Evaluation. During this stage criteria and indicators are established in order to measure the effectiveness of the education policy, collecting data, analyzing the impact of this policy on the education system and identifying areas of success and those that may need improvement and development.
6. Policy Revision or Modification. During this stage necessary adjustments to the education policy are made based on the data obtained and circumstances changes; goals are revisited; objectives and strategies are chosen to better align with the evolving needs of the higher education system.
7. Policy Communication. At this stage educators, parents, and the public share their opinion and clear guidelines on how the policy affects various aspects of the education system are provided and transparency and openness in the communication process are ensured.
8. Estimation and Improvement is the final stage. It includes establishing mechanisms for ongoing feedback from stakeholders, using feedback to make continuous improvements to the policy and its implementation and adapting to emerging trends and challenges in education (Sabatier and Weible, 2018).

So, to discuss global higher education management systems, we should mention that they depend greatly upon federal control and supervision, on one hand, and the community active participation in education management, on the other hand. In many Western European countries, like France and Germany, education is centralized with a very strong position of the government in their management and funding. In contrast, the US system is decentralized, with institutions having significant autonomy and freedom. It definitely depends on a world tendency to equate education to the market services; educational institutions that operate on market principles, treating education as a commodity, are often found in countries with policies influenced by liberalism. This approach is defined by the application of economic principles like competition and market dynamics to higher education, leading to outcomes like increased innovation and stronger industry ties, but also risks of lower quality and accessibility. The provision of education is based on supply and demand, with institutions and students interacting through a “price mechanism’. There is a move from direct government management toward greater privatization and private funding. The emphasis shifts to results, employability, and output rather than other educational values. Institutions compete with each other for students, funding, and reputation.

The global higher education market size was estimated at $ 736.80 billion in 2023 and is expected to demonstrate a compound annual growth rate (CAGR) of 12.1% from 2024 to 2030 (Fig. 2). The growing population in countries, like the United States of America, Canada, Great Britain, and India, higher education expansion is driven by the labor market needs. The demand of global labor market dictates international cooperation and collaboration between educational systems of these countries. Idea of continuous learning and development is becoming a growing trend as individuals look to advance their skills. The result of such collaboration is an increasing demand for University graduates with the internationally accepted degree, professional skills, and workshop training in their asset portfolio.

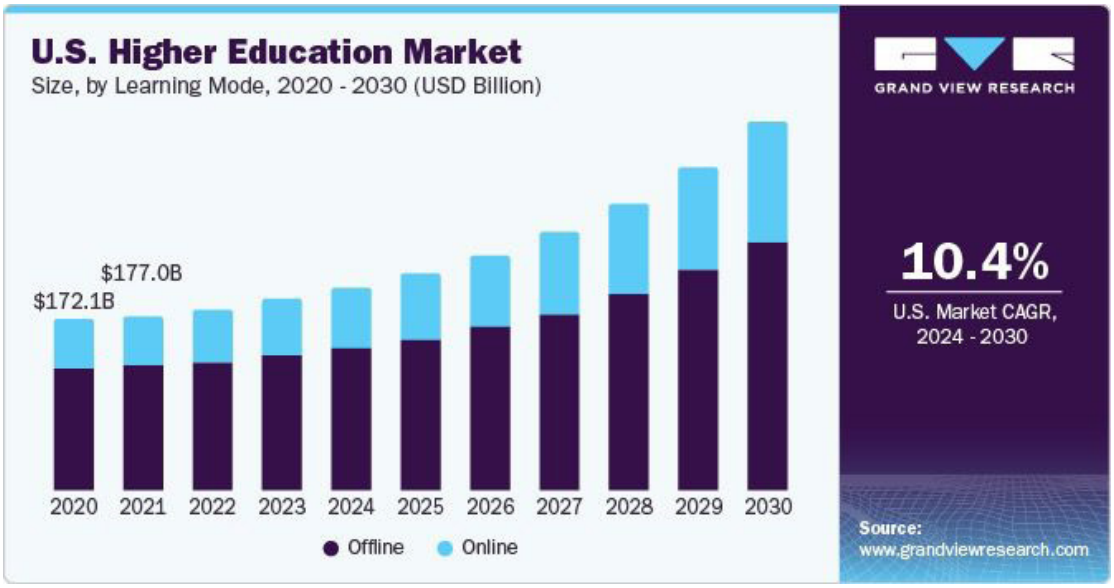

Figure 2. The global higher education market size 2020 to 2030 ($ Billion) (HEM Report, 2020)

The global market for higher education is a dynamic and rapidly evolving sector with its crucial role not only in providing knowledge and teaching skills, but also in shaping the future workforce and driving economic growth and national prosperity. Critical thinking, creative abilities, hard and soft skills are commodities in the global job market; so in order to comply with its demands higher education institutions must go in step with this market rapidly changing requirements and needs. It makes the education market to expand and to include various contemporary forms of learning like online and traditional offline education, distant teaching and learning, professional training, all of them complying with the growing needs of the labor market and the economy as a whole. Also hybrid models of education that combine in-person and digital instruction are popular. The market's growth is driven by several factors, including technological advancements, government initiatives, and the globalization of education.

State universities lead the market in 2024. This segment is growing as it offers education at a lower tuition cost compared to private institutions. They receive funding, subsidies and federal support, making it possible to provide students with financial benefits. Scholarship affordability attracts a broader spectrum of local population, providing opportunities for a greater number of students get higher education and become high-skilled professionals. A university system features multiple distinct universities under a common governing board, while a multi-campus university has several physically separate locations under a single institutional umbrella. Satellite or branch campuses are physically distant from a main campus and can be located in different cities, states, or even countries. North America dominated the market with a revenue share of around 30% in 2023. North American universities are at the forefront of research and innovation because of cutting-edge research facilities, technological innovations and scientific breakthroughs. Virtual and distance learning, personalized learning experiences, international students enrolment, digital educational programs fostering global collaboration, provide educated and skilled workforce not only for the USA economy, but make a contribution into the modern world human capital. These advancements position institutions as innovative global leaders, thereby increasing their attractiveness to both domestic and international applicants. Universities in the region are frequently located in innovation centers and ecosystems strongly related to industries. Furthermore, a strong presence of world-renowned universities and educational institutions in the U.S. and Canada supports region's growth.

Statistical analysis of the global higher education market includes the following:

Market Size and Growth. In 2023 the global higher education market was estimated at approximately USD 736.80 billion and still foreshows steady increase at a compound annual growth rate (CAGR) of 12.1% from 2024 to 2030.

Regional Insights. North America currently dominates the market, driven by advanced technologies, strong infrastructure, and high consumer spending power. Significant demand for higher education is also seen in regions like the U.S., Canada, the UK, and India, due to growing populations and the need for skilled labor.

Market Drivers. Increasing global demand for skilled professionals and the rise of online and hybrid learning models are major drivers. Federal financial support encourages education infrastructure improvement and affordability, boosting enrolment rates and increasing the outcomes.

Technological Advancements. Modern technologies like artificial intelligence (AI) and virtual reality (VR) provide students with innovative learning experiences, thus increasing the outcomes. Highly demanded cloud services allow educational institutions to preserve and retrieve data, apps, and resources effectively.

Trends and Innovations. The lifelong learning and up-skilling are to address workforce growing demands in the rapidly evolving world economy. Institutions are investing in creative areas to promote experiential learning across various subjects.

Economic Impact. Economic downturns and recessions can result in less public support for education and more competition for grants and scholarships. The widespread adoption of online and hybrid learning techniques is projected to boost market growth.

United States Higher Education Market Analysis

The U.S. higher education market is growing very well with excellent government funding and strong enrolment rates. In the fiscal year 2023, the budget for the U.S. Department of Education was about USD 79.1 billion with considerable amounts to be allocated towards research and programs for student financial aid.

According to an industry report, undergraduate enrolment saw a 1.2 percent increase from last year during the fall 2023 session which added around 176,000 students to college enrolment rolls nationally. The National Centre for Education Statistics noted that U.S. higher-education institutions delivered 2 million bachelor's degrees and 205,000 doctoral degrees in 2022-2023. Online education with hybrid learning is increasing market expansion, especially within technical and vocational training. Huge public universities are major players. However, along with state and public universities a growing number of highly popular private institutions are emerging, thus expanding global education offerings. The U.S. education is a major educational hub providing world labour markets with high-skilled professionals and highly educated researchers

Europe Higher Education Market Analysis

Higher education market in Europe is currently experiencing unprecedented growth, which can be explained by high government funding, unified educational standards, international student mobility, and research and development activities. In 2023, the European Union allocated around $ 87.42 billion to higher education. The region, therefore, commits to developing the opportunities of its people. Additionally, due to the EU innovation strategy within academia $ 408.10 billion in research and development activities was invested, reflecting its commitment to pioneer work in this area. The current tendency is to attract more students from other countries to European universities, with Germany and the United Kingdom (UK) leading the pack. According to an industry report, Germany saw a record number of 2.9 million students in 2023. It is not surprising that more students are going there because of educational programs such as Erasmus+ and DAAD, scholarships and grants for international student and faculty mobility, joint research projects, with financial aid reducing barriers and leverage regional initiatives. Renowned institutions like the University of Oxford and ETH Zurich continue to attract global talents. Such technological advances as digitalization and virtualization of education, online and hybrid learning programs continually expand free access to education and boost the market.

Asian Higher Education Market Analysis

The Asian higher education market in Pacific region is expanding due to federal funding, rising middle-class population, and international educational partnership. Key drivers include China's significant investment in education including $6.46 trillion in 2023. In 2024 education investment was characterized by a significant increase, which grew to $ 6.5 trillion. This was supported by a new strategic education plan that aimed to make China a global education leader, with a strong focus on research and international collaboration. Key initiatives included expanding access, strengthening vocational training, and targeted funding. India's enrolment grew to 43 million in 2023, and a great focus on skill-based technical training. This growth is establishing the Asia Pacific region as a major global hub for higher education.

Latin America Higher Education Market Analysis

According to ITA, education expenditure for 2022 in Brazil was $ 24 billion. The budget of the Brazilian Ministry of Education for 2023 is estimated at $ 29 billion. The basic education system in Brazil encompasses 46.7 million students, with 8.3 million in preschool, 26.5 million in elementary school, and 7.7 million in high school. The higher education sector has 8.4 million enrolled students', 75 percent of students are in private institutions, while the government emphasizes education highly and focuses on the internationalization of higher education significantly. Distance learning is gaining increased momentum with growing lower tuition fees and the suitability of programs for working populations. According to an industry report, around 355 institutions provide distance learning, and for the first time in 2023, the number of registrations for distance learning exceeded those for in-person courses. Brazil also ranks eighth in sending foreign students to U.S. universities, with 14,897 students enrolled during the 2021-2022 academic year.

Middle East and Africa Higher Education Market Analysis

The United Arab Emirates (UAE) is a highly competitive education market within the GCC region. According to ITA, education stands out as a top priority in the country, taking up 15.5% of the country's federal budget of USD 17.1 billion in 2023. The "National Strategy for Higher Education 2030" seeks to equip the labour market with technical and practical skills from students of the UAE. It is also supposed to change accreditation standards in order to harmonize curricula with international education programs. In the UAE's education system private schools and higher education establishments dominate, while the rest is a blend of public schools and higher education institutions. Being a multicultural community the U.S., UK, India, and the Dubai International Academic City in the UAE (accommodating 28 international universities) provide different international curricula in private schools. Investments and collaboration, such as those with the Rochester Institute of Technology, Dubai and New York University, Abu Dhabi, is rapidly transforming the higher education sector.

The global higher education market is expected to grow, with an estimation of USD 736.80 billion in 2023 and a projected compound annual growth rate (CAGR) of 12.1% from 2024 to 2030. Key trends and tendencies shaping this market include:

1. Demand for Education Increase: A population growth in countries like the U.S., Canada, the UK, and India is driving the demand for higher education institutions. The pursuit of skills advancement and continuous learning is leading to a rise in demand for graduate degrees and short workshops.
2. Diverse Educational Models: The educational market includes traditional institutions, also offering online learning platforms, vocational training centers, and hybrid models that combine in-person and digital instruction. This diversification allows for tailor-made education to different student segments, enabling lifelong learning and professional up-skilling.
3. State Universities' Dominance: State universities are leading the market due to lower tuition costs compared to private institutions, backed by government funding.

   This affordability attracts a wider demographic, enhancing enrolment rates.
4. Regional Insights:

   - Asia Pacific: Countries like China and India are making substantial contributions to higher education.

   - Latin America: Brazilian significant portion of private higher education is a result of past growth and the inability of the public sector to meet rising demand, though the prestige of public universities remains high due to stringent admission standards and a focus on research. Distance learning is gaining traction.

   - Middle East and Africa: The UAE education structures are focusing on equipping students with practical skills and improving educational standards.
5. Technological Advancements: Artificial intelligence (AI) and virtual reality (VR) are among the most important in education. Effective application of cloud computing and services will provide solutions in data management and storage within higher education institutions.
6. Economic Impact: Education depends on public expenditure for education, that's why adoption of online and hybrid learning strategies during the periods of economic fluctuations and crises is likely to drive education market growth and to keep it afloat.

In summary, the higher education market is increasingly characterized by a focus on accessibility, technological integration, and a diverse range of learning models, driven by the need for skilled professionals in a rapidly evolving economic landscape.

Results

As a result of the study the following conclusion can be made: to improve the efficiency and effectiveness of higher education management in Iraq and to significantly diversify educational services export and import to comply with the world educational system, modern managerial decision-making methods, such as Kepner-Tregoe, AHP decision-making methods can be implemented. To implement Kepner-Tregoe and AHP decision-making methods for selecting a perspective of higher education management systems in Iraq a brainstorming sessions with 4 experts in the subject area were conducted in the form of unstructured interview.

Step 1: Problem Definition. Iraqi higher education system is going through several challenges; some of them are outdated management, insufficient financial support, and defunct curricula. These issues slow down the overall education development, affecting student outcomes and the country's development.

Step 2: Requirements

1. Accessibility: This one includes providing financial aid, scholarships and grants in order to make education more accessible, constructing more institutional facilities in underserved areas would also solve the problem.
2. Quality: Curricula update and staff in-service professional training should impact on education quality, enhance strategies and methods, and ensure meeting international educational standards and benchmarks.
3. Equity: Address disparities in educational opportunities and resources among different regions and demographic groups to ensure fair and equal access to quality education for all students.
4. Professional Development: Investment in teachers' continuing professional development should be through pre-services and in-services. Also salaries, grants and scholarships should be aimed at retaining qualified educators within the system.
5. Infrastructure: Upgrade and maintain educational facilities, including classrooms, laboratories, libraries, and computer classes to create a creative teaching and learning environment.

Step 3: Goals

1. Improve student outcomes: Increase literacy, numeracy, soft and critical thinking skills among students to better prepare the workforce for the future careers and further studies by embedding human-centred competencies and reinvigorating sustainability.
2. Enhance quality of teaching: Attract, retain, and educate qualified professionals in the field of education through offering competitive salaries, career opportunities, pre-services, in-services and a favourable educational environment.
3. Modernize the curriculum: Match the curriculum to the 21st century requirements and equip students for a competitive graduate marketplace.
4. Expand access: ensure universal access to higher education and a better quality of learning through better policies focusing on scholarships and financial aid, and building more institutions.
5. Improve school infrastructure: Equip educational institutions with modern teaching and learning facilities, support equitable access for all children regardless of socioeconomic background, by removing financial barriers, increasing available places, and providing a conductive environment for effective teaching and learning.

Step 4: Alternatives

1. Increase government spending on education: A widely recommended policy, leading to better students' outcomes, higher test scores and graduation rates, increased adult earnings and reduced poverty.
2. Implement educational reforms: Apply technological innovations, upgrade curricula, encourage teacher professional development through pre-service and in-service training, apply skill-based teaching strategies, evaluate student advancement and outputs.

3. Promote private sector involvement: Welcome private funding in education and improve infrastructure for educational services, while the public sector retains oversight and ensures access and quality. These might include private partners building and managing educational facilities, providing educational management services, developing curriculum, and investing in technology.
4. Strengthen teacher training and development: Offer pre-service and in-service professional development for the staff, make changes significant for digital and blending education, take systematic effort to provide free and accessible education for educators.
5. Improve educational technology: Apply online resources for teaching and learning experiences, to stimulate interactivity of knowledge acquisition.

Step 5: Criteria

1. Student achievement: Use norm-referenced tests and criterion-referenced tests to identify students' gaps or successes in order to adjust teaching methods, improve curriculum, and provide targeted support, with ongoing analysis being key.
2. Teacher satisfaction: Implement all measures possible to attract and to retain skilled and devoted teachers, and overall job satisfaction school engagement can be significantly increased, student discipline cab be enhanced, and a motivated and committed teaching workforce can be ensured.
3. Equity: Evaluate the distribution of educational resources and opportunities across different regions and demographics to ensure fair access to quality education for all students.
4. Cost-effectiveness: Consider the financial implications of each alternative and its potential return on investment to ensure that resources are used efficiently and effectively.
5. Sustainability: Assess the long-term viability and scalability of each solution to ensure the education system improvement over time.

Step 6: Decision-Making Tool Selection

Kepner-Tregoe (KT) Decision Analysis;
Analytic Hierarchy Process (AHP).

Step 7: Evaluate Alternatives against Criteria

Selected decision-making tools will help to evaluate alternatives against criteria.

Step 8: Valid solution

Based on the analysis of goals and alternatives, the most promising alternatives appear to be a combination of increased government spending, educational reforms, and teacher training and development. These approaches have the potential to address multiple challenges and improve the overall quality of education in Iraq.

The Kepner-Tregoe method is a structured decision-making and problem-solving process that helps identify the best possible choice, not a perfect one, by systematically evaluating alternatives and reducing risks through a quantitative comparison of options against defined criteria. The approach emphasizes gathering objective, factual information to minimize bias and focuses on a logical, step-by-step analysis to make rational, well-reasoned decisions.

Table1. *Selecting a perspective of higher education management systems in Iraq using Kepner-Trego Decision Making Method*

Increased government spending				
Criterion	Weight	Criteria description	Score	Final Score
Student achievement	10	Percentage of students passing standardized tests	8	80
Teacher satisfaction	8	Teacher retention rates	9	72
Equity	7	Student-teacher ratios	7	49
Cost-effectiveness	6	Expenditures per student	8	48
Sustainability	5	Long-term funding sources: Government budget + private donations	9	45
				294
Educational reforms				
Student achievement	10	Percentage of students passing standardized tests	9	90
Teacher satisfaction	8	Teacher retention rates	8	64
Equity	7	Student-teacher ratios	9	63
Cost-effectiveness	6	Expenditures per student	7	42
Sustainability	5	Long-term funding sources: Government budget + private donations	6	30
				289
Private sector involvement				
Student achievement	10	Percentage of students passing standardized tests	7	70
Teacher satisfaction	8	Teacher retention rates	6	48
Equity	7	Student-teacher ratios	8	56
Cost-effectiveness	6	Expenditures per student	9	54
Sustainability	5	Long-term funding sources: Government budget + private donations	7	35
				263
Teacher training and development				
Student achievement	10	Percentage of students passing standardized tests	8	80
Teacher satisfaction	8	Teacher retention rates	10	80
Equity	7	Student-teacher ratios	7	49
Cost-effectiveness	6	Expenditures per student	6	36
Sustainability	5	Long-term funding sources: Government budget + private donations	6	30
				275
Educational technology				
Student achievement	10	Percentage of students passing standardized tests	8	80
Teacher satisfaction	8	Teacher retention rates	7	56
Equity	7	Student-teacher ratios	7	49
Cost-effectiveness	6	Expenditures per student	8	48
Sustainability	5	Long-term funding sources: Government budget + private donations	8	40
				273

Valid Solution: Based on **increased government spending** (294) and **educational reforms (289)** appear as being the most promising alternatives. A positive assessment of two opinions concerning Iraq's education system, suggesting they offer viable solutions to the nation's challenges in the field of education. These issues include inequitable financial support, invalid infrastructure, and inadequate facilities.

Since one of the objectives in our study is to offer managerial decisions' for Iraqi higher education management system's problems and challenges, we will also consider the Analytic Hierarchy Process (AHP) method. The algorithm for applying the methodology and tools of the Analytic Hierarchy Process method is presented in the following sequential Tables 2-8:

Table2. *Pair-wise comparison of selected criteria for higher education management systems in Iraq*

Criterion	Student achievement	Teacher satisfaction	Equity	Cost-effectiveness	Sustainability	Geomean	Normalised weight
Student achievement	1	3	5	4	3	2.825	0.454397
Teacher satisfaction	1/3	1	4	3	2	1.515	0.243781
Equity	1/5	1/4	1	3	2	0.786	0.126417
Cost-effectiveness	1/4	1/3	1/3	1	2	0.560	0.090225
Sustainability	1/3	1/2	1/2	1/2	1	0.529	0.085180
					Total	6.217	1

Table 3. *Alternative Comparisons for "Student achievement" criteria*

Alternative	Increased government spending	Educational reforms	Private sector involvement	Teacher training and development	Educational technology	Geomean	Normalised weight
Increased government spending	1	3	2	4	3	2.352	**0.399185**
Educational reforms	1/3	1	3	2	2	1.319	**0.223933**
Private sector involvement	1/2	1/3	1	3	2	1	**0.16971**
Teacher training and development	1/4	1/2	1/3	1	3	0.659	**0.111967**
Educational technology	1/3	1	1/2	1/3	1	0.560	**0.095203**
					Total	5.89	1

Table 4. *Alternative Comparisons for "Teacher satisfaction" criteria*

Alternative	Increased government spending	Educational reforms	Private sector involvement	Teacher training and development	Educational technology	Geomean	Normalised weight
Increased government spending	1	2	3	4	2	2.16	**0.373395**
Educational reforms	1/2	1	3	2	3	1.55	**0.267158**
Private sector involvement	1/3	1/3	1	2	3	0.922	**0.158745**
Teacher training and development	1/4	1/2	1/2	1	3	0.71	**0.123174**
Educational technology	1/2	1/3	1/3	1/3	1	0.45	**0.077525**
					Total	5.80	1

Table 5. *Alternative Comparisons for "Equity" criteria*

Alternative	Increased government spending	Educational reforms	Private sector involvement	Teacher training and development	Educational technology	Geomean	Normalised weight
Increased government spending	1	2	3	2	4	2.16	**0.381959**
Educational reforms	1/2	1	2	1	3	1.24	**0.219377**
Private sector involvement	1/3	1/2	1	3	2	1	**0.176103**
Teacher training and development	1/2	1	1/3	1	2	0.80	**0.141365**
Educational technology	1/4	1/3	1/2	1/2	1	0.46	**0.081193**
					Total	5.67	1

Table 6. *Alternative Comparisons for "Cost-effectiveness" criteria*

Alternative	Increased government spending	Educational reforms	Private sector involvement	Teacher training and development	Educational technology	Geomean	Normalised weight
Increased government spending	1	3	2	4	3	2.35	**0.399185**
Educational reforms	1/3	1	3	2	2	1.31	**0.223933**
Private sector involvement	1/2	1/3	1	3	2	1	**0.16971**
Teacher training and development	1/4	1/2	1/3	1	3	0.65	**0.111967**
Educational technology	1/3	1	1/2	1/3	1	0.56	**0.095203**
					Total	5.89	1

Table 7. *Alternative Comparisons for "Sustainability" criteria*

Alternative	Increased government spending	Educational reforms	Private sector involvement	Teacher training and development	Educational technology	Geomean	Normalised weight
Increased government spending	1	2	3	4	3	2.35	**0.406590**
Educational reforms	1/2	1	2	1	3	1.24	**0.215335**
Private sector involvement	1/3	1/2	1	3	2	1	**0.172858**
Teacher training and development	1/4	1	1/3	1	2	0.69	**0.120798**
Educational technology	1/3	1/3	1/2	1/2	1	0.48	**0.084417**
					Total	5.78	1

Table 8. *Selecting a perspective of higher education management systems in Iraq using Analytic Hierarchy Process (AHS) decision-making method*

Criteria Want Objectives	Normalized Criteria Weight	Normalized Alternative Score	Total Score
Increased government spending			
Student achievement	0.454397	0.399185	0.18138847
Teacher satisfaction	0.243781	0.373395	0.09102661
Equity	0.126417	0.381959	0.04828611
Cost-effectiveness	0.090225	0.399185	0.03601647
Sustainability	0.085180	0.406590	0.03463334
			0.391351
Educational reforms			
Student achievement	0.454397	0.223933	0.10175448
Teacher satisfaction	0.243781	0.267158	0.06512804
Equity	0.126417	0.219377	0.02773298
Cost-effectiveness	0.090225	0.223933	0.02020435
Sustainability	0.085180	0.215335	0.01834224
			0.233162
Private sector involvement			
Student achievement	0.454397	0.16971	0.07711571
Teacher satisfaction	0.243781	0.158745	0.03869901
Equity	0.126417	0.176103	0.02226241
Cost-effectiveness	0.090225	0.16971	0.01531208
Sustainability	0.085180	0.172858	0.01472404
			0.168113
Teacher training and development			
Student achievement	0.454397	0.111967	0.05087747
Teacher satisfaction	0.243781	0.123174	0.03002748
Equity	0.126417	0.141365	0.01787094
Cost-effectiveness	0.090225	0.111967	0.01010222
Sustainability	0.085180	0.120798	0.01028957
			0.119168
Educational technology			
Student achievement	0.454397	0.095203	0.04325996
Teacher satisfaction	0.243781	0.077525	0.01889912
Equity	0.126417	0.081193	0.01026428
Cost-effectiveness	0.090225	0.095203	0.00858969
Sustainability	0.085180	0.084417	0.00719064
			0.088204

Valid Solution: The sum of the weighted ratings shows that increased government spending is the closest to the needs and goals. Increased federal support meets all the requirements of the education system, which means that increased government spending is the most successful choice.

Both methods used in the study offer approaches aimed at well-informed choices. The Kepner-Tregoe method, with its focus on risk assessment and quantitative comparison against predefined criteria, effectively identifies the most promising alternatives based on weighted scores. In the provided analysis,

"Increased federal support (government spending)" and "Educational reforms" emerged as the strongest contenders through this method. Complementarily, the AHP method delves deeper into the subjective importance of criteria through pair-wise comparisons, generating normalized weights involves applying a normalization technique to convert raw performance scores into a common, comparable scale, often between 0 and 1, to ensure fair comparison across different criteria. This process, as demonstrated in the tables, also points towards "Increased federal support" as the preferable option by yielding the highest total weighted score. By systematically evaluating alternatives against weighted criteria, both methods contribute to more efficient decision-making, minimizing potential risks and maximizing the likelihood of achieving desired outcomes in the context of higher education management systems in Iraq.

Discussions

Iraq is modern country with a rich ancient cultural history and the oldest in the world educational traditions. It has a lot to offer. Unfortunately, due to constant conflicts and political instability, Iraq was excluded from the list of safe countries for tourism and education.

A university structure can be viewed as a three-tiered hierarchy. In it centre of the university administration model there are teachers and students, engaged directly in teaching and learning (Balmasova, 2016). The middle, managerial level (e.g., department heads and deans) acts as a buffer and bridge between the core and the outer, institutional level. This outer level, comprising senior administrators like university presidents, interacts with the external environment.

Typically, there is a loose connection between the centre and the outer levels, beneficial for preserving educational goals but resistant to updating teaching methods. For a system to function well, it is crucial to have professional professors, which requires support and development (Anastasiadou and Taraza, 2020). Universities must also balance teaching and research priorities, reflecting that balance in their promotion standards. High-quality teaching, in fact, serves as a foundation for high-quality research. In the Iraqi context, however, several cultural and structural issues hinder progress. For instance, the Ministry of Higher education (MOHESR) uses ineffective methods to combat corruption, such as requiring faculty to submit multiple exam sets. This not only fails to address the real problem but also fosters resentment among staff.

Furthermore, a "culture of survival" has developed due to past national crises. In this culture, problems are concealed from higher authorities, reports are often unrealistic, and many administrators are unwilling to acknowledge the true situation. This leads to a widespread denial of system issues and a deep-seated resistance to change, as people fear for their job security. Any meaning reform challenges not only actions but also deeply held beliefs, ensuring that responses to external pressures, like international accreditation, are often minimal and purely for show (Makarova, Makarova and Al-Mashhdani, 2024).

Finally, a significant cultural shift has occurred among students. Having entered a globally connected world after 2003, they can adjust to international educational standards. This has led to widespread disappointment and, with limited avenues for constructive expression, sometimes to aggressive behavior. This student dissatisfaction represents a major internal resistance. However, this same frustration could be harnessed as a powerful force for change if students were convicted that serious efforts were being made to enhance programs, teaching methods, and facilities.

Conclusions

The Iraqi higher education system possesses a rich history and the potential for significant growth. Understanding the complexities of this system is crucial for several reasons.

Firstly, it is the cornerstone of progress, "informed" is the key word here. To move further to international standards, education should use an approach based on information, not on assumptions or outdated policies.

Data-Driven Decisions - this approach relies on concrete data. This allows governments to move from reactive fixes to proactive, targeted strategies (Al Hiali et al., 2023).

Addressing Specific Challenges - for example, a critical shortage of engineers, gap in technological experts, but a surplus of humanities graduates. Informed policy could then create targeted scholarships to

support engineering fields, rather than applying a blanket funding cut or increases across all disciplines.

Resource Optimization ensures that limited public funds are allocated where they are most needed and will have the greatest impact, whether for infrastructure, faculty development, or student financial aid.

Consequently, by analyzing the Iraqi system, we can gain valuable insights into the challenges and compare the results with those systems in other countries experiencing political transition or facing security threats.

Secondly, we identify that no country has a monopoly on good ideas. Russia, with its long-storied academic tradition, is a pertinent case study.

- Learning from Diverse Models: Collaborating with Russian institutions can provide insights into their rigorous curricula and research methodologies.
- Managing a Vast and Diverse System: Like other large nations, Russia has the challenge of managing higher education across a huge geographical area with varying regional needs. Exchanging best practices on how to ensure quality and equity between flagship metropolitan universities and those in remote regions is invaluable.
- Joint Research and Development: Collaboration is about creating knowledge together. Partnerships can lead to joint research projects in areas of mutual interest, such as Arctic studies, nuclear energy, or computer science, pooling intellectual resources for greater innovation.

Thirdly, to strengthen the arguments is that we can add a point focused on the direct benefits to the core mission of universities: teaching and learning.

A well-managed and internationally engaged higher education system directly improves the educational experience for students and the teaching capacity of faculty.

- Curriculum Modernization: By analyzing global trends and labor market requirements, education should develop critical thinking, digital literacy, adaptability and flexibility.
- Faculty Development: International students enrolment should help them bring new experiences back to their home classrooms, raising the overall quality of instruction.
- Student Mobility and Global Competence: Structured international partnerships facilitate student exchange programs, dual degrees, and joint seminars. This prepares students to be global citizens, able to work in diverse and international environments.

The two points form a powerful rationale. By combining internal analysis for smart policymaking with external one with global goals can add a focus on enhancing direct educational outcomes for students and faculty creates a complete picture of strategic improvement.

The primary goal of this research is to conduct a comprehensive analysis of the current state of the Iraqi higher education and to offer recommendations for its improvement to comply with the world standards of higher education and to make Iraqi Universities appreciated by international students from all over the world.

Three hypotheses were proposed to succeed in this goal achievement and improvements implementation:

Hypothesis 1. Analyzing the Iraqi higher education systems could reveal valuable insights into effective management practices in order to identify common challenges and problems and also to find solutions of the issues pinpointed.

Hypothesis 2. Modern management techniques such as the Kepner-Tregoe (KT) method and Analytic Hierarchy Process (AHP) implementation provides a structured approach for prioritizing objectives and evaluating alternatives by analyzing strengths and weaknesses, while AHP uses a hierarchical framework to prioritize criteria and make complex decisions through paired comparisons. These methods being based on systematic data provides more informed and objective decision-making in any sector, high education area in particular.

Hypothesis 3: Staff and student mobility assist national higher education system through the other countries positive experiences in the field of higher education.

This research focuses on improving the Iraqi higher education system by examining hypotheses related to academic quality, management and institutional strategy. To build a resilient sector, the findings suggest solutions must address core issues across these three levels and involve students, faculty, administration, government, and the community. Problems often span multiple levels, requiring integrated

solutions that consider their interconnected nature, such as providing student support services (managerial/institutional) to enhance enrolment and academic success (core). Modern management methods would help educational system to revive and prosper and to enter international education as an equal partner.

The provided article describes a common issue in Iraqi universities: an overemphasis on theoretical knowledge at the expense of developing practical skills and positive student attitudes. This is evident in delivering lectures and exams focused on sheer memorization, which may be due to a shortage of qualified teachers, limited access to modern equipment, and the unstable security situation hindering off-campus training. However, the neglect of student attitudes cannot be excused by these factors.

We believe in the cultural values that will help to attract international students and align Iraq's higher education with global educational standards, an approach focusing on updating university governance and curriculum is needed, emphasizing international students and faculty mobility, student financial support, and a competitive learning environment. Key strategies include developing English-language teaching programs, international joint projects, campus infrastructure enhancement, and teaching methods amendment in order to design high-quality educational environment that would provide Iraq's cultural, economic and educational reconstruction.

Although challenges that include lack of basic resources, the shortage of foreign students in Iraqi campuses, the exodus of qualified professors and academics, religious, national, ethnic conflicts, exist, the need to modernize content and move away from outdated or divisive material, the perspectives for the changes are rather promising, including modernization of school and university buildings and teaching materials, attracting professional highly-qualified teachers, giving equal educational opportunities to women, rural citizens, and displaced communities.

In conclusion, we have articulated the foundational role that education plays in rebuilding a nation. We consider education not as an equal sector among many, but as the bedrock upon which all other sectors depend. Our hope is that the Iraqi Education System as the "indispensable key factor" could revitalize the social fabric, tighten social links, and ensure a brighter future for all citizens. There exists an urgent and compelling need for a more comprehensive, strategically conceived, and diligently implemented reconstruction effort than one that solely focuses on short-term humanitarian assistance or the mere physical rehabilitation of damaged social infrastructure. Instead, the primary focus must be centered on systemic and deeply rooted reform processes that address the fundamental causes of the existing challenges and promote sustainable long-term improvement and innovation across the entire educational spectrum. Despite the significant problems and challenges that resist transformation in education, the updated education system following the best world universities patterns would assist in sustainable changes in the future, assisted by the spirit of dialogue between all stakeholders.

We hope that concerted collective efforts would contribute to reinvigoration of society, strong political commitment, consistent investment into education both from the private investors and the federal funding, developmental changes and sustainable infrastructure of higher education. This one would help capture new growth opportunities, social protection to address climate change in educational policies, digitalization of educational process, and provide insights into survival and flourishing of Iraqi higher education system. This collective endeavor holds the key to unlocking the vast potential of Iraq's future generations and contributing to the nation's long-term stability and prosperity. As it has mentioned, education is one of the most powerful tools for de-radicalization. It provides a positive, alternative narrative to that of extremist groups, grounded in knowledge, tolerance, and hope for the future. A government that provides a quality public good like education builds legitimacy and trust with its people.

Widespread educational opportunity reduces the sense of injustice and marginalization that often fuels political instability and conflict. When young people see a path to a better life through education, they are less likely to be recruited by violent movements. Education itself is a key to prosperity, freedom and equality of all citizens in the country.

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Author Contributions

Conceptualization, M.E.A., M.E.L. and A.D.T.; methodology, M.E.A., M.E.L. and A.D.T.; software, M.E.L. and A.D.T.; formal analysis, M.E.L. & A.D.T.; writing—original draft preparation, M.E.A., M.E.L. and A.D.T.; writing—review and editing, M.E.A. and M.E.L. All authors have read and agreed to the published version of the manuscript.

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Development of ADDIE Instructional Design Model Based Social Participation Skills in Secondary School Students

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Abstract: The increasing prevalence of contemporary social problems, together with citizens' indifference toward these issues, indicates a deficiency in individuals' social participation skills. This concern, which serves as the foundation of the present study, seeks to enhance secondary school students' social participation skills while providing social studies teachers with a systematic framework to support the development of these competencies. In this context, this study designed the process of developing social participation skills for 5th graders by following the stages of the ADDIE instructional design model within the scope of the social studies course. The study adopted a mixed-methods research design that integrated quantitative and qualitative approaches. The analysis and evaluation phases employed a case study design, while the design, development, and implementation phases were structured around activity-based and problem-centered instructional design models. The sample group of the study consisted of social studies teachers and 5th graders in Gölcük District of Kocaeli Province. The findings indicate that the activities implemented to foster social participation skills enhanced fifth graders' awareness of social issues, increased their level of social consciousness, and contributed to more positive perceptions of non-governmental organizations. In addition, a statistically significant difference was observed between students' pretest and posttest scores on the social participation skills assessment.

Keywords: *Skills, participation, social participation skill, social studies.*

Introduction

The biggest portion in generating a democratic society is the active participation of citizens in social development processes. While establishing a strong individual-society bond brings about the development of society in every sense, it is clear that it also contributes to the rapid increase in the democratic development indicators. Democratic societies require citizens who participate in the social and democratic processes in order to ensure this sustainability. In order for citizens to have a social consciousness, they are expected to participate in some activities in relation to their society and humanity in the context of local, national and global dimensions. It is simply because the active participation of the individual in social life is considerably significant for both the individual self and the society s/he is in (Jerome, 2024; Kıncal, 2012).

As far as the democratic history of the world is concerned, it has always required difficult struggles and individual efforts for people to possess certain rights as well as acquire them. It is evident that the citizens of countries with strong democracy, respect for human rights, and development in terms of personal rights and freedoms are active in the social life and also possess advanced knowledge, skills and competencies regarding citizenship. The individuals with these skills are generally called "Active Citizens" or "Operative Citizens" by the scientific community. Possessing superior qualifications in a democratic sense is a long-term process (Granados-Sánchez, 2023).

Needless to say, individuals cannot be expect ed to become active citizens instantaneously; this process requires a long period of time, starting with the individual's primary school life and continuing during his/her adolescence (Kuş, Karatekin and Merey, 2012). When active citizenship is examined conceptually, it is clear that citizenship essentially emphasizes participation (Habermas, 1994; Geier and Hasager, 2020).

In developed countries, it is apparent that nations are increasingly prioritizing efforts to enhance

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the knowledge, skills, and values of young individuals in order to equip them to address social and global challenges and to foster their development as active and participatory citizens (Hablemitoğlu and Özmete, 2012). In particular, substantial importance is attached to children's development of actions and policies that directly affect them (such as education, health and environmental problems) and their participation in the implementation of these policies (Lúcio and l'Anson, 2015). This is, however, only possible if individuals develop democratic skills and values by adapting to society from an early age. The positioning of students as active agents within the multilayered structures of local, national, and global societies; the enhancement of their competencies for engagement in social and political life; and the cultivation of heightened awareness and internalization of fundamental principles such as democracy, the rule of law, and human rights collectively constitute the essence of social participation skills. In contemporary societies, the increasingly pronounced need for social sensitivity, active citizenship, and democratic engagement has rendered the enhancement of students' social participation skills an urgent scholarly and educational imperative. Accordingly, the present study emerges as a critical necessity, as it seeks to offer comprehensive theoretical and practical contributions aimed at strengthening students' social participation skills and fostering the development of a more responsive, inclusive, and participatory social order..

Social norms are a very important foundation during the socialization of the individual or his/her integration into the society s/he lives in. Informal citizenship education acquired through the social environment and formal citizenship education acquired in the school environment constitute the basis of the individual's participation in society. As far as review of the last 50 years in terms of citizenship education is concerned, it is evident that there has been a smooth transition from traditional to modern citizenship education. In the traditional citizenship education, the emphasis was on individuals' acquiring a national identity, strengthening their loyalty to the notion of state and nation, and educating them as adaptable and authority- faithful individuals (Gollob, Krapf and Weidinger, 2010). In modern citizenship education, conversely, it is clear that the initiative sought to instill in students certain responsibilities, including preparing them to function as members of a multi-centered and multi-layered society spanning local, national, and global contexts, as well as supporting the development of competencies such as engagement in social and political life principles such as democracy, the rule of law and human rights and ensuring greater social justice (Şen, 2019). When the traditional and modern citizenship education are compared, it is possible to say that the most important achievement is the individual's transition from passive receptivity to active participation. Therefore, it is vitally significant for the students to develop their social participation skills and raise awareness regarding social problems (Hauge and Rowsell, 2020).

Social participation, as a result of the necessity of living together, has emerged from the need for individuals to be involved in social dynamics in every field and assuming an active role in addressing social issues is a fundamental component of social participation. It is crucial for citizens to undertake responsibilities beginning within their immediate environment and to engage in efforts aimed at resolving or improving social problems that affect communities and nations of varying scales (Flanagan, 2004). Furthermore, prior research has emphasized that adequate income levels and quality education constitute essential conditions for meaningful participation within societies (Sokolow, 2011).

Social participation leads the way for individuals to develop a useful personality and become active citizens in the future (Levine, 2007). Therefore, it is commonly accepted by many educators that there is a positive relationship between social skills and social participation (Vogelgesang, 2009). Students' recognition about the problems of the society they live in, developing their social sensitivity, and attempting to benefit all humanity, starting from the environment they live in with a sense of responsibility, can all be acknowledged as the impacts of education on social participation skills. The principal indicators guiding this study encompass multidimensional measures designed to assess the existing state of students' social participation skills, to structure the activity-based instructional process, and to evaluate the effectiveness of the implemented interventions. Initially, a needs analysis aimed at identifying students' current proficiency levels in social participation functions as the foundational step of the research. Within this framework, identifying the negative conditions encountered in the teaching environment based on teachers' perspectives serves as a critical indicator that reveals both the challenges experienced in the educational process and the structural and pedagogical factors that hinder the development of social participation skills.

The second main indicator involves assessing students' prerequisite knowledge and social sensitivity levels through scales and interview forms. These indicators reveal the cognitive and affective

foundations necessary for students to exhibit social participation behaviors and enable the identification of special needs related to the intervention process through empirical data. The level of students' social sensitivity (which comprises multidimensional constructs such as their interest in societal issues, propensity for empathy, and sense of social responsibility) serves as a significant preliminary indicator within the scope of this study. The third key indicator relates to the planning of in-class and out-of-class activities designed to develop social participation skills, based on the analysis results. This indicator defines the pedagogical strategies and the nature of the learning experiences that shape the practical aspect of the study. Data regarding the structure, intensity, and goals of the activities provide a crucial roadmap for determining which methods are most effective in improving students' social participation behaviors. Finally, the study's outcome indicators consist of measuring students' behavioral changes related to social participation at the end of the intervention and evaluating the effectiveness of the implemented activities. These indicators reveal both the success of the intervention and the extent to which social participation skills have improved, thus playing a central role in assessing the overall effectiveness of the study. These behavioral changes are analyzed through concrete outcomes such as assuming social responsibility, willingness to participate in social activities, participation in problem-solving processes, and increased awareness of democratic values. All these indicators, when considered together, these elements indicate that the study approaches the development of students' social participation skills through a systematic and comprehensive framework that integrates needs assessment, instructional design, implementation, and evaluative processes.

The ADDIE model (Analyze, Design, Develop, Implement, Evaluate) constitutes a systematic and iterative instructional design framework, deriving its name from the initial letters of its sequential phases. As a comprehensive paradigm for the planning, enactment, and evaluation of instructional processes, the model is extensively employed by instructional designers and educators to construct pedagogically robust and learner-centered learning experiences (Özerbaş and Kaya, 2017). Grounded in an analytical and evidence-informed design logic, ADDIE seeks to structure the instructional process by integrating learner characteristics, content specifications, and pedagogical objectives. In doing so, it facilitates the systematic organization of learning environments and fosters meaningful learning experiences across cognitive, affective, and psychomotor domains (Reiser and Dempsey, 2012).

Originally conceptualized to guide the development and delivery of knowledge, skills, and attitudes, the model promotes the systematic incorporation of assessment and feedback mechanisms throughout all stages of the instructional cycle. This holistic orientation emphasizes that instructional design extends beyond the mere production of instructional materials; rather, it functions as a dynamic and continuously evolving process aimed at enhancing instructional effectiveness (Cheung, 2016). The inherent structural flexibility of the ADDIE model enables its adaptation and implementation across both online learning contexts and traditional face-to-face instructional settings. Consequently, it has become a widely recognized instructional design standard applicable across diverse disciplines, heterogeneous learner populations, and rapidly transforming educational technology ecosystems (Aldoobie, 2015).

The central problem of the study is comprised of the question 'How should the social participation skills of 5th grade secondary school students be developed within the scope of social studies course based on the ADDIE instructional design model?'

The sub-problems of the study are as follows:

1. What are the suggestions of teachers for the application of the ADDIE instructional design model for social participation skills in the fifth grade secondary school social studies course?
2. What are the design, development and implementation stages for social participation skills in the fifth grade secondary school social studies course based on the ADDIE teaching model?
3. What is the evaluation phase for social participation skills in the fifth grade secondary school social studies course based on the ADDIE instructional design model?

Materials and Methods

Research Model

In the process of cultivating social participation skills, the study employed a mixed-methods approach, incorporating both qualitative and quantitative research techniques and utilizing multiple data collection instruments within a single research framework (Creswell, 2016; Greene, Kreider and Mayer, 2005). The procedures of the ADDIE instructional design model were systematically followed throughout the study. In alignment with this model, the five phases of the research were structured as follows: In the initial phase, a descriptive case study design was adopted to identify the challenges encountered in the instruction of social participation skills. Subsequently, the design, development, and implementation phases were organized using activity-based and problem-centered instructional design approaches. In the fifth stage, an explorative case study was chosen in order to identify the effect of the activities on the students.

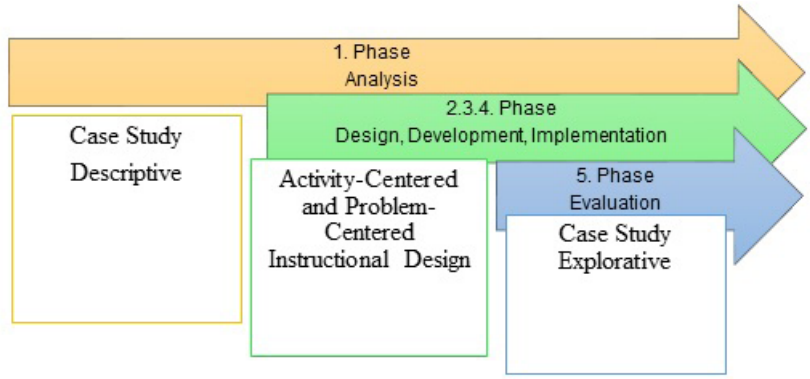

Figure 1. Research steps based on the ADDIE instructional design model

Population and Sample

The population of the study consisted of fifth grade students and social studies teachers teaching in the Kocaeli Gölcük district. In deciding the sample based on the established study population, convenience sampling technique was chosen among the purposeful sampling method (Yıldırım and Şimşek, 2016; Sömen, 2016). The sample consisted of 48 social studies teachers teaching in public schools in Gölcük district in the 2020-2021 academic year, while the study was conducted with 537 students in the analysis phase and with 22 fifth grade secondary school students in the 2021-2022 academic year in the implementation phase.

Data Collection Tools

As data collection tools, scale, skill-based test and rubric were used in the quantitative part; semi-structured interview forms, student information forms and activity evaluation forms were used in the qualitative part. The measurement tools used were as follows.

- The "Social Sensitivity Scale" (SSS) developed by Öcal, Demirkaya and Altınok (2013). The scale, which consisted of a total of 24 items, had two factors. The first factor (sensitivity to individual problems) consisted of 15 items, and the second factor (sensitivity to social problems) consisted of 9 items. Prior to the present study, the reliability of the scale, which was applied to a different sample group (n=218), all of which were 5th grade students, was tested and it was found that the Cronbach's Alpha value was .92.
- Prerequisite Knowledge Questions: The prerequisite knowledge questions prepared by the researcher taking into account the achievements of the relevant units, were developed to analyze the students' existing knowledge levels regarding their social participation skills. Primarily, a table of specifications was created in order to identify the distribution of social participation skills based on achievements. The achievements in the table of specifications were derived from the key concepts in the subjects available in the textbooks. The reason for preparing a short-answer test instead of multiple choice is

to establish students' prerequisite knowledge more clearly and also to identify misconceptions, if any.

- The semi-structured interview form consisting of 8 questions prepared by the researcher was generated to reveal the thoughts and experiences of social studies teachers regarding the social participation skills and to identify their needs in teaching social participation skills to the students.
- The skill-based test, designed as open-ended problem scenarios and containing current problems, had a total of 24 expressions, eight dimensions and three expressions under each dimension, aiming to measure the student's social participation skills. In these dimensions of the test, it was intended to measure high-level cognitive features such as problem solving, analytical thinking, critical thinking and decision making, and affective characteristics such as observation, sensitivity and empathy.
- Rubric (graded rubric), 3 types of criteria used when scoring skill-based tests were scored in 4 stages (1-4 points).

Research Process

In the study, initially, an application for research permission was made by the Ministry of National Education, and then the research process commenced after the required Ethics Committee decision was received by Bursa Uludağ University and the essential permissions were obtained from the Ministry of Education Kocaeli Provincial Directorate of National Education. The study was carried out in 5 stages based on the ADDIE instructional design model. Primarily, analysis phase of the study was implemented in the first semester of the 2020-2021 academic year with secondary school students in public schools in the Gölcük District of Kocaeli Province and the social studies teachers in Gölcük District. Afterwards, following the analysis findings, activities were designed and developed in order to improve social participation skills. These developed activities were implemented in the first semester of the 2021-2022 academic year in September, October and November. An evaluation was performed through skill-based tests and activity evaluation forms applied after the activities regarding the social participation skills, and the process was eventually completed. The study carried out within the scope of the ADDIE instructional design model, which formed the general framework of the research and the basis of the method, was briefly as follows. (Figure 2)

1-Analysis Phase
• Literature Review
• Analysis of Teacher Skills Teaching Needs
• Determination of Student Prerequisite Information
• Student Social Responsiveness Scale Analysis
• Analysis of SBDÖP and Textbooks
• Parent Meetings Student Recognition
• Grade-level Achievement-Behavior Indicator Table
2- Design Phase
• Skills-Based Test Design
• Rubric Design
• Observation and Interview Forms
• Activities for Skill-Based Teaching
• Activities for Problem-Based Teaching
• Expert Opinion
3- Development Phase
• Developing Activities for Social Participation Skills
• Editing Observation Forms
• Expert Opinion
4-Implementation Phase
• Implementation of events
• Monitoring Social Participation Skill Development
• Observation of Student Performances
5- Evaluation Phase
• 1-Process Evaluation
• Evaluation of the Realization Process of Activities
• 2-Evaluation of Results
• Evaluation of Student Performances
• Evaluation of Teacher Opinion
• Skills Based Test Results

Figure 2. Research application steps based on the ADDIE

Data Collection and Analysis

The data collected for the study were examined by subjecting them to quantitative and qualitative analyses processes. SPPS 22.0 package program was used for quantitative data. The "Social Sensitivity Scale", "Social Participation Skill Test" and "Prerequisite Knowledge Questions", which were included in the analysis phase of the study, were analyzed. Initially, it was checked whether the data showed a normal distribution. It was then decided which test to perform on the data. Since the SSS findings did not show a normal distribution, the Mann Whitney U-test, one of the non-parametric tests, was used. In the analysis of the skill-based test and prerequisite knowledge questions, another social studies teacher was also allowed to score, and it was found that the correlation between the scores was very high, .92. This is very important for the reliability of the study. Furthermore, the effect value size (Cohen) of the pretest-posttest score differences of the social participation skill test was also calculated within the quantitative data.

In the qualitative dimension of the study, the MAXQDA 20 program was used within the scope of content analysis. Semi-structured interview forms and activity evaluation forms with teachers were transferred to the program as Word, Excel or PDF, and then coding was created. Based on these codes, themes were obtained. During the data analysis process of the interview forms, the analysis was made by a different coder in order to clear the coding from errors and individual misconceptions, and it was found that the coherency between the coders was .90 (90%). This rate showed that reliability and coherency were high because it was stated that a fit of .80 (80%) and above was sufficient (Miles and Huberman, 2019). Moreover, qualitative findings were supported through the direct quotations during the explanation of the coding.

Results

1. Needs analysis of social participation skills in the fifth grade social studies course in middle school according to the ADDIE instructional design model

a- Analysis of social studies teachers' current practices on how to improve social participation skills and their suggestions on how to improve social participation skills

A semi-structured interview form was administered to identify the problems experienced by the social studies teachers in the education and training process regarding the social participation skills and to establish their needs for the process, and as a result of the analysis, the following findings were obtained.

Table 1. *Activities for Teaching Social Participation Skills in Social Studies Classes*

	f	%
Studies related to the course are carried out	28	58
Extracurricular activities are held	12	25
A variety of knowledge and information is provided	5	10
Life experiences are shared	3	7
Total	48	100

As far as the interviews are concerned, it is evident that most of the activities carried out by the social studies teachers (58%) were performed during the lesson and in accordance with the textbook. 25% of the teachers stated that they did extracurricular activities and that the activities included charity bazaars, social clubs and social service activities. Furthermore, while 10% of the teachers provided a variety of knowledge and information about social participation, 7% of them shared their life experiences with the students (Table 1).

Table 2. *Suggestions for Improving Social Studies Teachers' Social Participation Skills*

		f	%
Cooperation should be made with the non-governmental organizations		12	25
Extracurricular activities should be implemented		10	21
Various practices should be performed during the lessons.		9	18
Case studies should be conducted		5	11
Individual and group work should be offered		5	11
Community service work should be encouraged		4	8
Social clubs should be made more operational		3	6
	Total	48	100

As far as the interviews are concerned, regarding their needs to develop social participation skills in students, (25%) of the social studies teachers stated that cooperation with non-governmental organizations was crucially significant and (21%) expressed the need to organize extracurricular activities (community service, social and cultural events, charity bazaars, aid and solidarity organizations, nature activities). Moreover, (18%) of the teachers emphasized the need for practical activities in the social studies lessons, (11%) for case studies, (11%) for individual and group studies, and (8%) for community service work (6%) emphasized the need to activate social clubs (Table 2).

b- What are the students' social sensitivity and prerequisite levels?

The "Social Sensitivity Scale" (SSS) of 5th grade secondary school students were administered to a total of 537 students, 271 girls and 266 boys in 7 different public secondary schools in the Gölcük district of Kocaeli Province. The results obtained from the scale are as follows.

Table 3. *Students' social awareness levels*

Level	Range	F (n)	Percentage (%)
Low	*24-56*	*4*	*0.7*
Middle	*57- 88*	*38*	*7.1*
High	*89-120*	*495*	*92.2*
Total	*24-120*	*537*	*100*

N=537; X^2=109.67; Ss=13.23

In order to identify the level of sensitivity of fifth grade secondary school students regarding individual problems, the total scores of each student from the items were calculated and averaged. The lowest score that could be obtained from the sensitivity dimension of the scale regarding individual problems was 15 and the highest score was 75. Therefore, the score between 15-35 corresponded to low level, the score between 36-56 corresponded to medium level, and the score between 57-75 corresponded to high level. When Table 34 is examined, it is evident that 4 (0.7%) of the 537 students participating in the study had low sensitivity to individual problems, 39 (7.3%) of them had medium and 494 (92%) of them had high sensitivity. The average of students' sensitivity levels regarding individual problems was X^2=69.13. This finding demonstrated that the sensitivity levels of fifth grade secondary school students regarding individual problems were also at a high level (Table 3).

c- What are the prerequisite levels of students' social participation skills?

Another component of the needs analysis phase of the study was to identify the prerequisite knowledge levels of 22 5th grade students in the experimental group regarding social participation skills. The research questions consisted of 10 open-ended questions. Analytical rubric prepared by the researcher was used to score students' responses to the questions. The answers given by the students were scored and the following results were obtained.

Table 4. *Prerequisite Knowledge Levels of Students Regarding Social Participation Skills*

Prerequisite Knowledge Level	f	%
Low (1-10)	5	22,7
Average (10-20)	12	54,5
Qualified (20-30)	4	18,3
Highly Qualified (30-40)	1	4,5
Total	22	100

As far as the results of the analysis are concerned, there was only one student (4.5%) who answered the questions at a highly qualified level, while there were four students (18.3%) who answered the questions at a qualified level. Moreover, as a result of the answers given by the students to the questions, it was revealed that the largest concentration was at the average level (54.5%) and five students were at the low level (22.7%). The evaluation of the students' answers to the prerequisite knowledge questions regarding social participation skills is as follows: Given the results in Table 3, the students who answered the questions in a qualified and highly qualified manner were considered competent. Other students' answers were considered relatively average or inadequate (Table 4).

2. Design, development and implementation stages of social participation skills in the fifth grade social studies course in middle school according to the ADDIE teaching model.

Guided by the ADDIE instructional design framework, the study proceeded with the design, development, and implementation of instructional activities aimed at fostering students' social participation skills. The activities were structured in line with activity-based and problem-centered teaching approaches, and the criteria informing their development are presented as follows:

1. Initially, the relevant literature was reviewed and the scope and limitations of social participation skills in the social studies course were highlighted.
2. By analyzing the 2005 and 2018 Social Studies Course Curriculum (SSCC), the social participation skills were analyzed in the program and textbook contents. Target behaviors and achievements were identified with the prepared specification table.
3. The results of the interviews with social studies teachers constituted the framework of the activity design phase. Therefore, the findings obtained from the studies directly and indirectly guided the event design phase.
4. Focus group interviews with the social studies teachers and field experts' opinions established the activities' compatibility with the level and course subjects and their curricular and extracurricular limitations.
5. During the implementation process, the institutions to be cooperated with (non-governmental organizations, neighborhood headman) were contacted, the imperative legal permissions were obtained and the time planning of the activities was made.
6. A work plan was created for the planned activities, and as a final control, the opinions of two field expert academicians and three social studies teachers were consulted.

In the design process based on the ADDIE teaching model, initially, the framework of the activities planned to develop social participation skills was created. While preparing the curricular and extracurricular activities to be performed within the scope of this general framework, the following points were taken into consideration:

a) It should be related to Social Studies Course Curriculum (SSCC) outcome,
b) The activities conducted should have the quality that supports the Ministry of National Education social activities regulations,
c) The activities should be prepared by taking into account achievements that can be associated with social participation skills within the scope of celebrations of certain nationally significant days and weeks in schools,
d) Other skills and values related to social participation skills should be considered,

In this sense, the skills related to social participation skills were identified as; problem solving, empathy, entrepreneurship, cooperation, critical thinking, observation, decision making, self-control and the relevant values; responsibility (especially social responsibility), sensitivity, solidarity and helpfulness.

Consequently, in the light of the opinions of three social studies teachers and two field experts, the activities planned to be implemented in line with the above-mentioned items were classified as curricular and extracurricular. Furthermore, the activities that could be implemented on certain nationally significant days and weeks were developed in order to improve the social participation skills.

During the design phase, based on the results of the needs analysis conducted especially with the social studies teachers, the situations required for social participation skills were attempted to be identified. Consequently, the general framework for the activities to be designed in the process of developing social participation skills were generated as follows.

1. The requirement to cooperate with non-governmental organizations.
2. Endeavors to help the students to learn their basic rights and responsibilities.
3. Offering activities that will enable the students to acquire sensitivity to social problems (especially socially focused environmental awareness).
4. Students should be able to know how to solve problems when they encounter a social problem in daily life.
5. Endeavors to organize activities will support social development and contribute to social harmony.

Based on the Social Studies Course Curriculum (SSCC) and a comprehensive review of the literature, the intended behavioral outcomes associated with students' social participation skills to be attained through the designed activities are specified as follows:

- Acting sensitively towards the social events transpiring around him.
- Acknowledging what participation signifies and being able to participate at a simple level within the means and opportunities of the place where he/she lives.
- Recognizing the non-governmental organizations and being able to cooperate with them when necessary.
- Acknowledging the limits of their fundamental rights and freedoms.
- Acknowledging their rights as children and being aware of the situations in which these rights are violated.
- Recognizing the characteristics that a conscious consumer should possess and acting responsibly.
- Possessing basic knowledge of the functioning of the official institutions and organizations.

Another important issue in the process of creating activities was to design activities that include three domain dimensions consisting of students' cognitive, affective and behavioral. It is simply because the studies in the relevant literature emphasized that social participation skill was a multidimensional skill and that it was important for students to acquire the learning outcomes, especially in the affective field (awareness, sensitivity, volunteering).

A total of eight activities were implemented within the scope of the implementation process of the study. Prior to each activity, the students were informed about the process and at the end of the process, data were collected through the activity evaluation forms. During the activity implementation process, observations were made by the researcher and notes were taken about the activities.

3. The evaluation phase of social participation skills in the fifth grade social studies course in middle school according to the ADDIE instructional design model.

a. Findings Regarding the Pretest-Posttest Scores of the Social Participation Skills Test of 5th Grade Secondary School Students

Table 5. *Dependent sample t-test analysis results of students' social participation skill pre-test and post-test scores*

	N	X^2	Ss	t	p
Pretes	22	68.85	11.89	-23.662	.000
postte	22	95.80	11.53		
Total	*44*				

When Table 5 is examined, it is evident that the difference between the pre-test and post-test scores of the students from the social participation skill test was significant (t_{19}=-23.662, p<.05). Considering the arithmetic averages of the difference scores, it is clear that this observed difference was in favor of the post-test. When the effect value size of the difference in pretest-posttest scores was calculated (Cohen = .75), it was concluded that it had a medium level effect size (between .60-.80). Therefore, it is possible to say that the practices had a positive impact on the social participation skills of secondary school students.

b. Findings Regarding the Behavior Change Observed in the Students After Activities aimed at Improving Social Participation Skills

A "student opinion form" consisting of two questions was administered to the students regarding their general evaluation of the activities carried out and what contribution these activities made to them, and the opinions of the students were obtained through this form. Regarding the effectiveness of the activities carried out within the scope of social participation skills, students were asked the following question: "Do you think all the activities carried out within the scope of social participation skills were useful and why?" and their answers were analyzed.

Within the scope of the present study, unexceptionally all (100%) of the students stated that the activities carried out within the scope of social participation skills were useful. Some students gave more than one reason why they were useful. In line with the answers given regarding the usefulness of social participation skills, categories were created and the answers were tabulated in Figure 3.

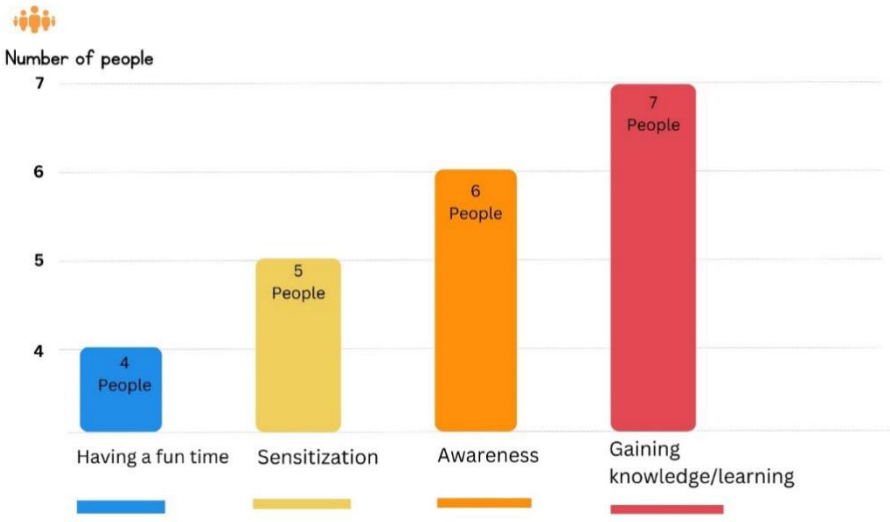

Figure 2. Categories regarding students' responses that social participation skill activities were helpful

When Figure 3 is examined, the students stated that they "were informed/learned" (f=7), "became conscious" (f=6), "gained sensitivity" (f=5) and "had a fun time" (f=4) as a result of the activities. Therefore, they believed that the activities were useful.

Discussions and Conclusion

The social participation skill is an important skill that needs to be developed in students. It is commonly emphasized that it is significant to make designs that encourage both researchers and educators to develop this skill (Mc Loughlin et al., 2023). Furthermore, the question of how children should take part in the society is frequently a matter of heated discussion (Martini et. al, 2023; Hauge and Rowsell, 2020; Torney-Purta, 2006). The purpose of the present study was to foster the development of social participation skills among fifth-grade students by implementing the ADDIE instructional design framework in the social studies curriculum. In the first place, a needs analysis was conducted in an attempt to help the students to improve this skill. All the social studies teachers (100%), who were an important part of the needs analysis, stated that their students could not sufficiently acquire the social participation skills. This particular result confirmed the starting point of the problem statement of this study. The fact that students failed to acquire the majority of behaviors, attitudes and skills related to social participation skills (Mutlu and Öztürk, 2017; Gelen, 2002) or only partially developed them (Çelikkaya, 2011), and that the teachers had positive opinions but failed to convert these positive opinions into desired behavior during the implementation phase. were among the results that were revealed by the other studies (Mutlu and Öztürk, 2017).

The analysis of semi-structured interviews with Social Studies teachers revealed several key themes related to the challenges and needs encountered in teaching social participation skills. The findings indicated that most activities aimed at developing social engagement skills are implemented in the classroom and are predominantly textbook-based (58%). This suggests that teachers tend to adopt traditional, curriculum-based teaching practices when addressing social engagement skills. A smaller portion of teachers (25%) reported involving students in extracurricular activities. These activities were described as charity fairs, participation in school-based social clubs, and community service activities, suggesting limited experiential learning opportunities outside the classroom. Furthermore, 10% of teachers reported providing various informative input on social engagement, while only 7% reported sharing personal life experiences with students to support the development of social engagement skills. Overall, these findings suggest that teaching practices designed to develop social engagement skills are largely limited to classroom-based, text-focused approaches, and relatively few teachers embrace experiential or community-centered learning. The limited use of extracurricular activities and the rare integration of real-life experiences suggest that broader pedagogical support, more resources, and professional development opportunities are needed to enable teachers to more effectively develop social engagement skills through diverse and authentic learning contexts. It was also stated that the extracurricular activities should be organized around the concept of community service, which aimed to help members of the community and included volunteer work and activities ranging from making donations to charities and working as volunteers for the community (Arthur et al., 2017; Moely et al., 2002; Toncar et al., 2006). It was further concluded that the extracurricular activities such as nature education, official institution visits, scientific and artistic activities, and participation in local community activities, which were the most prominent activities among extracurricular activities, had positive effects on the social studies course and improved the course success rate of the students (Selanik-Ay, 2010; Gökçe, 2015; Meydan, 2015; Keçe, 2015; Karadeniz, 2015; Çolak, 2015; Özür and Şahin, 2017).

Furthermore, the social studies teachers stated that the most important thing to be done to improve students' social participation skills was to cooperate with the non-governmental organizations (25%) and to engage in extracurricular activities (21%) (community service activities, social and cultural events, charity bazaars, cooperation and solidarity organizations, nature activities, etc.). They also stated that the practical activities (%18) should be performed in the social studies classes (18%). In particular, NGO and school collaboration generated an environment where students could learn citizenship skills by enjoying and experiencing them (McMurray and Niens, 2012; Park, Senegačnik, and Wango, 2007; Ribeiro, Rodrigues, Caetano, Pais and Menezes, 2012). The social studies teachers should organize joint activities with NGOs within the scope of active citizenship for their students in their classes, and they should contribute to the students' active participation in NGOs (Eryılmaz, Bursa and Ersoy, 2018).

As part of the needs assessment component of the study, the prerequisite knowledge levels of 22 fifth-grade students in the experimental group regarding social participation skills were assessed using

a set of ten open-ended questions. Student responses were evaluated using an analytical rubric developed by the researcher. The distribution of students' prerequisite knowledge levels is presented in Table 4 in the findings section. The findings indicate that only one student (4.5%) achieved a fairly proficient level of prerequisite knowledge, while four students (18.3%) were classified as proficient. A significant portion of students (54.5%) clustered at the average level, while five students (22.7%) demonstrated low prerequisite knowledge. This distribution suggests that most students possess only partial or limited conceptual understanding of social participation skills. According to the assessment criteria, students who responded proficiently or highly proficiently were considered to have sufficient prerequisite knowledge, while students in the average and low categories were considered to have insufficient or relatively weak understanding. The majority of students in the average range indicate that their current knowledge is not strong enough to support high-level competencies in social participation without targeted instructional intervention. Moreover, the high proportion of students demonstrating limited proficiency underscores the necessity of providing well-organized and systematic instructional experiences to strengthen foundational concepts. Overall, these findings highlight a clear need for educational activities designed to enhance students' initial knowledge base regarding social participation. The identified gaps justify the implementation of the planned intervention program and confirm the importance and urgency of supporting students' development in this area.

As far as the scale results are concerned, it is evident that the students' social sensitivity levels were high (92%). In the study conducted by Ünal and Duygu (2019), as a result of applying the same scale (SSS) to 7th and 8th grade students, it was concluded that the female students were more sensitive than the male students to both individual and social problems. Rotolo and Wilson (2007) stated in their study on social participation that the female students, even though insignificantly, received higher scores than the male students. It was also believed that students' inherent aptitude differences were related to the fact that the female students entered puberty earlier than the male students (De Bolle et al., 2015).

Analysis of the pre-test and post-test results administered to fifth-grade middle school students demonstrates a statistically significant improvement in social engagement skills. Mean pre-test scores increased from 68.85 to 95.80. A paired-samples t-test revealed a significant difference in favor of the post-test (t_{19} = -23.662, $p < 0.05$). These results demonstrate that the intervention had a positive and measurable impact on students' social engagement skills.

Furthermore, the qualitative feedback from students supports the quantitative findings. All participants (100%) reported that the activities were beneficial to them. Among the reported results, 31.8% of students reported increased knowledge, 27.2% increased awareness, 22.7% increased sensitivity to social issues, and 18.1% emphasized that the activities were enjoyable. The findings demonstrate that the intervention supports students' understanding of social participation at both the cognitive and affective levels, which are integral to the development of active citizenship. Furthermore, a positive association was observed between higher academic achievement and performance in social participation tasks. This aligns with previous research by Hurtado and DeAngelo (2012), who found a significant and consistent relationship between academic performance and the acquisition of civic skills among university students. Such evidence suggests that cognitive skills and academic participation can facilitate the development of social participation competencies and highlight the interconnectedness of academic achievement and civic participation.

The findings also highlight the fundamental role of the Social Studies curriculum in developing students' social participation skills. Given its close connection to real-life contexts and societal issues, the course provides ample opportunities for experiential learning and critical analysis of societal issues. By integrating carefully designed activities with local resources and aligning them with specific dates, weeks, or thematic activities, educators can further enrich the curriculum and maximize the potential to foster active social participation among students.

In conclusion, the study provides both quantitative and qualitative evidence that structured interventions in Social Studies can effectively develop middle school students' social participation skills encompassing cognitive, emotional, and behavioral dimensions. The positive results highlight the importance of purposeful pedagogical planning, the integration of experiential activities, and leveraging local contexts to cultivate engaged and socially responsible students.

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Conflict of interests

The authors declare that there is no conflict of interest with any institution or person within the scope of the study.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

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Not applicable.

Author Contributions

Conceptualization, T:K,; methodology, T.K and E.A.; software, T.K.; formal analysis, T.K.; writing—original draft preparation, T.K. and E.A.; writing—review and editing, T.K. and E.A. All authors have read and agreed to the published version of the manuscript.

Ethics

Ethics committee approval was obtained for the current research by Bursa Uludağ University Research and Publication Ethics Committees with the decision dated 27/07/2020 and session number 2020-05.

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A Hybrid SWARA-NWA Framework for Evaluating AI-Based Image Recognition Algorithms in Educational Technology Applications

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Abstract: Artificial Intelligence (AI) and computer vision technologies are increasingly integrated into educational environments through intelligent tutoring systems, gesture-based learning, facial expression analysis, and automated evaluation tools. However, selecting the most appropriate image recognition algorithms for educational applications remains a challenge due to varying requirements regarding speed, accuracy, hardware compatibility, and usability in dynamic classroom conditions.This paper proposes a hybrid multi-criteria decision-making (MCDM) model based on the Step-wise Weight Assessment Ratio Analysis (SWARA) and Net Worth Analysis (NWA) methods to evaluate and rank nine widely used AI-based visual recognition algorithms. The evaluation is conducted using five education-relevant criteria: processing speed, recognition accuracy, robustness to classroom noise, compatibility with low-end devices, and energy efficiency. Expert assessments from the field of educational technology were used to derive weight coefficients and evaluate algorithm performance.The results show that Fast R-CNN achieved the highest overall score (1.141), followed by U-Net (1.077) and DeepLab (1.062), indicating their suitability for real-time and resource-constrained EdTech environments. Algorithms such as MobileNet (1.057) and YOLO (1.037) also demonstrated balanced performance, making them viable for mobile or moderately demanding educational scenarios. The proposed model offers a structured and transparent decision-support framework that can assist researchers and practitioners in selecting optimal AI algorithms for diverse educational applications.

Keywords: *Educational technology, Artificial intelligence, Computer vision, Multi-criteria decision making (MCDM) and Algorithm evaluation.*

Introduction

In the past decade, artificial intelligence (AI) technologies have become a key component of the educational sector, enabling personalized instruction, automated assessment, student behavior detection, and real-time learning analytics (Rane et al., 2023; Chen et al., 2020; Li et al., 2023). A particularly significant role in this development is played by computer vision algorithms, which are applied in handwriting recognition, facial expression analysis, student attendance tracking, and gesture-based interactive learning (Zabulis, Baltzakis and Argyros, 2009). However, these algorithms are predominantly developed for industrial applications, and their direct use in education is often hindered by requirements such as low hardware demand, interpretability, and energy efficiency. Modern educational institutions, especially those implementing smart classrooms or mobile EdTech platforms, face the challenge of selecting AI algorithms that are both pedagogically appropriate and technically feasible (Dimitriadou and Lanitis, 2023).

In the context of Serbia's ongoing digital educational reform, these challenges gain further com-

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plexity. The *National Education Development Strategy of the Republic of Serbia until 2030* envisions an intensive digitalization of the teaching process, with an emphasis on improving digital competencies of teachers and students, as well as the integration of digital tools into everyday classroom practice. During the COVID-19 pandemic, the mandatory use of learning management systems (LMS) at the school level, marked the beginning of a systemic digital transformation in the education sector (Ibrahim et al., 2020). In this direction, the *e-Dnevnik* platform has been widely adopted for electronic documentation of pedagogical processes, while the *Unified Information System of Education (JISP)* has become a crucial tool for monitoring and analyzing educational data at the national level (Krstev et al., 2024).

Additionally, the conference *"The World Ahead of Us – Education in the Era of Artificial Intelligence,"* held at the Palace of Serbia, highlighted the latest advancements in AI applications in education, with particular emphasis on the potential of personalized learning, intelligent tutoring systems, and large-scale educational data analytics. These developments underscore the growing need for the development and evaluation of AI algorithms (Kayal, 2024) that are not only technologically efficient but also aligned with pedagogical principles and infrastructural limitations of schools. In line with this, Adžić and colleagues (2024) provide evidence that the acceptance of AI, particularly generative tools, varies across different educational contexts, further emphasizing the necessity for transparent and adaptable evaluation frameworks.

The selection process is further complicated by the fact that decision-makers are often not technical experts, which highlights the need for structured, transparent, and replicable evaluation models (Sampson et al., 2019). In this context, the present study proposes a hybrid multi-criteria decision-making (MCDM) framework that integrates the SWARA (Step-wise Weight Assessment Ratio Analysis) method with Net Worth Analysis (NWA) to evaluate and rank nine contemporary AI algorithms for visual recognition. Drawing on domain expertise in educational technology, the proposed model enables the assessment of algorithms based on criteria that reflect the actual needs of the education system: processing speed, accuracy, robustness to noise, energy efficiency, and suitability for low-end hardware (Tariq et al., 2024).

This approach addresses a gap in the current literature, as most previous studies applying MCDM methods have focused on the selection of e-learning platforms, curricula, or teaching methodologies, while the selection of AI algorithms for educational purposes remains underexplored. The proposed model facilitates a balance between technical performance and educational usability, serving as a practical tool for evidence-based decision-making in the process of educational digital transformation.

Theoretical Framework

In the field of educational engineering, decision-making is increasingly guided by quantitative and systematic approaches, particularly in the selection of technologies, teaching methodologies, educational tools, and infrastructural solutions (Buenaño-Fernandez et al., 2019). Within this context, Multi-Criteria Decision Making (MCDM) has emerged as a particularly valuable framework, enabling the evaluation of multiple alternatives based on a variety of often conflicting criteria (Massam, 1988). MCDM methods have proven useful in non-trivial decision-making scenarios that require alignment between technical, pedagogical, organizational, and economic considerations, a fact supported by numerous educational studies (Malik et al., 2021). Recent examples include: Toan et al. (2021), who employed a hybrid MCDM approach for evaluating e-learning platforms in higher education; Keshavarz-Ghorabaee et al. (2018), who demonstrated the utility of SWARA and AHP models in selecting digital teaching tools; and Chen and Luo (2023), who illustrated the effectiveness of fuzzy logic-based MCDM models in assessing teaching quality. Similarly, Mahmoodi et al. (2025) applied MCDM methods to the selection of teaching strategies in STEM education, while Troussas et al. (2025) found TOPSIS and VIKOR techniques beneficial in planning educational infrastructure for primary schools. Marinović et al. (2025) published research optimizing the selection of operating systems within educational contexts.

The Role of MCDM Methods in Educational Contexts

Educational engineering involves the application of engineering principles, systems theory, and design methodologies to the educational process (Dym, 2004). As institutions face increasingly complex decisions, such as the selection of e-learning platforms, learning analytics tools, digital content, and AI algorithms, there is a growing need for transparent and replicable evaluation methods (Colchester et al., 2017).

MCDM methods allow for a structured analysis of alternatives using sets of both quantitative and qualitative criteria (Sahoo and Goswami, 2023). Their value in education is particularly evident in the following cases:

- Assessment of digital learning tools and platforms,
- Evaluation and selection of adaptive learning software,
- Design of data-driven curricula and instructional strategies,
- Ranking of teaching methods based on learning outcomes,
- Selection of technologies for smart classrooms or AR/VR systems,
- Evaluation of AI algorithms for behavior analysis, automated grading, or visual recognition.

Over the past decade, the application of MCDM approaches in education has grown exponentially, both in research and practice, due to their capacity to integrate expert judgment with available data (Nguyen, 2024). This trend is further substantiated by recent studies that emphasize the integration of artificial intelligence in education, such as the work by Milićević et al. (2024), which outlines current challenges in the implementation of AI in Serbia's educational system, and Tsankov and Levunlieve (2024), who examine the structured design of digital content in early childhood education.

Beyond academic insights, concrete shifts in Serbia's educational landscape further highlight the relevance of MCDM approaches. The introduction of the Unified Information System of Education (JISP), mandatory use of the e-Dnevnik platform, and the nationwide transition to accredited LMS systems illustrate the complexity of selecting technologies that must meet pedagogical, technical, security, and regulatory requirements. By applying MCDM methods, school administrators, ministries, and educational experts can make informed, rational, and well-documented decisions while balancing trade-offs between competing factors such as cost, accessibility, scalability, local support, and personalization capacity (Popović and Popović, 2021; Popović et al., 2022).

Moreover, educational development strategies, not only in Serbia and the Western Balkans, but across developed countries, underscore the need for methodological frameworks that support the evaluation and selection of AI solutions in line with strategic goals and the real capacities of educational systems. In this context, the integration of MCDM methods such as SWARA, AHP, TOPSIS, and NWA is not only desirable but essential for the systemic digital transformation of education.

Most Commonly Used MCDM Methods in Education

The most frequently used MCDM methods in educational research and practice include: Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Step-wise Weight Assessment Ratio Analysis (SWARA), Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE), and PIvotal Point of the Relative Criteria Impact Assessment (PIPRECIA). These methods provide structured and systematic evaluations of multiple alternatives based on a range of criteria-a particularly important feature in educational settings where decisions often involve selecting technologies, curricula, instructional strategies, or student assessment methods. Their application facilitates more transparent, objective, and adaptable decision-making by addressing the inherent complexity of the educational process and incorporating the diverse perspectives of stakeholders (Viennet and Pont, 2017). In recent years, there has been an increasing number of studies combining MCDM methods with expertise in educational technology to optimize tools and strategies (Alshamsi et al., 2023).

Analytic Hierarchy Process (AHP)

AHP is one of the most widely used methods, designed for hierarchically structuring problems and performing pair wise comparisons of criteria and alternatives. Its popularity in education stems from its ability to break down complex decisions into smaller, logically related components that are easier to analyze. The method supports expert subjective judgments and converts them into quantitative values, enabling the analysis of qualitative aspects within education. As such, AHP has become an important tool for strategic educational decision-making across all levels of governance (Vaidya and Kumar, 2006).

Common educational applications include:

- Selection of distance learning platforms,
- Prioritization of educational objectives,
- Evaluation of educational program quality.

Its advantages lie in its systematic structure and analytical rigor, while its limitations include complexity when handling many criteria and the requirement to check consistency.

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS identifies the optimal solution as the one closest to the ideal and farthest from the worst case scenario. This method is especially useful in education due to its clear and intuitive ranking of alternatives against predefined criteria. Its ability to balance between positive and negative ideal values makes it suitable for decision making situations that require compromise, which is often the case in educational practice. Because of its flexibility and transparency, TOPSIS has become a favored tool among researchers and policy makers in the education sector (Behzadian et al., 2012).

Applications include:

- Ranking teaching strategies,
- Selection of technologies in higher education,
- Evaluation of educational applications.

While TOPSIS offers intuitive interpretation, it relies on proper data normalization and accurate weighting.

Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE)

PROMETHEE uses preference functions and provides flexibility in assessing qualitative criteria. It is particularly suitable for complex educational problems involving multiple alternatives with differing characteristics. Its ability to process both quantitative and qualitative data makes it valuable for analyses involving subjective values, such as pedagogical approaches, student motivation, or the interactivity of learning materials. PROMETHEE also offers visualization through GAIA planes, facilitating decision making in educational institutions (Brans and Mareschal, 2005).

It is commonly applied in:

- Selecting teaching methodologies,
- Choosing courses within study programs,
- Analyzing educational scenarios.

However, it requires expertise in defining preference functions, which can be challenging for non-experts.

Step-wise Weight Assessment Ratio Analysis (SWARA)

SWARA is designed to determine weighting coefficients based on expert opinion. Its strength lies in its ability to transparently convert qualitative expert assessments into quantitative values suitable for MCDM analysis. It is particularly applicable in educational contexts where exact data may be lacking, and expert knowledge is the primary decision making resource. For these reasons, SWARA was selected as the most appropriate method for achieving the research goals of this study (Keršulienė et al., 2010).

Advantages include:

- Ease of application,
- Suitability for expert-driven contexts,
- Support for consensus-based decision-making.

In educational engineering, SWARA is used to:

- Prioritize learning quality factors,
- Evaluate technology selection criteria,
- Determine the importance of competencies in curricula.

Its intuitive structure and lower cognitive load make SWARA especially suitable for educational institutions.

PIvotal Point of the Relative Criteria Impact Assessment (PIPRECIA)

PIPRECIA uses a penalization approach to determine the relative importance of criteria. Unlike traditional weighting methods, it incorporates the influence of each subsequent evaluation through a

penalization mechanism, enabling more precise prioritization. It is thus well suited for complex decisions involving numerous criteria and stakeholders. In academic environments, PIPRECIA has proven to be a fast and effective method that delivers consistent results with minimal cognitive burden for experts. Its strength lies in its efficiency when dealing with large sets of criteria and in providing timely results. It is increasingly applied in educational studies, particularly for evaluating policies, strategies, and new curricular designs (Pamučar and Ćirović, 2015).

Integration of MCDM Methods with Educational Technology Systems

In the context of Serbia's digital transformation of education, there is a pressing need for multi-criteria decision models that combine expert knowledge with quantitative data. The proposed hybrid model integrates AHP, TOPSIS, PROMETHEE, SWARA, and PIPRECIA, enabling comprehensive and flexible analysis of educational decisions. AHP structures the problem and determines weights; TOPSIS identifies optimal solutions based on proximity to ideal values; PROMETHEE addresses subjective aspects through preference functions; SWARA facilitates the integration of expert opinions; and PIPRECIA allows efficient evaluation through penalization. This model can be applied to selecting digital platforms, evaluating AI solutions, budgeting for EdTech, and supporting school level digital decision-making. It is compatible with tools such as MATLAB, Excel, Python libraries, and interactive web platforms, offering visualization, interactive analysis, and real-time adaptability. The SWARA–NWA approach further balances subjective expert insight with objective algorithm performance, enhancing methodological transparency and applicability in educational practice.

Relevance for Selecting AI Algorithms in Education

Most existing research on MCDM in education focuses on the selection of platforms, learning methods, or instructional content. However, the growing use of artificial intelligence and computer vision in educational applications, such as automated grading, visual analytics, and behavior detection, necessitates the use of MCDM techniques to support the selection of appropriate AI algorithms.

This study addresses that gap by:

- Defining criteria relevant to the educational context (e.g., computational efficiency, pattern accuracy, robustness to noise),
- Applying a well-established hybrid MCDM approach (SWARA–NWA),
- And evaluating a set of widely-used computer vision algorithms that are increasingly adopted in educational systems.

Methodology

This study (see Figure 1) employs a hybrid Multi-Criteria Decision-Making (MCDM) approach, combining the Step-wise Weight Assessment Ratio Analysis (SWARA) method for determining the relative importance of evaluation criteria and the Net Worth Analysis (NWA) method for calculating overall scores and ranking AI algorithms in an educational technology context.

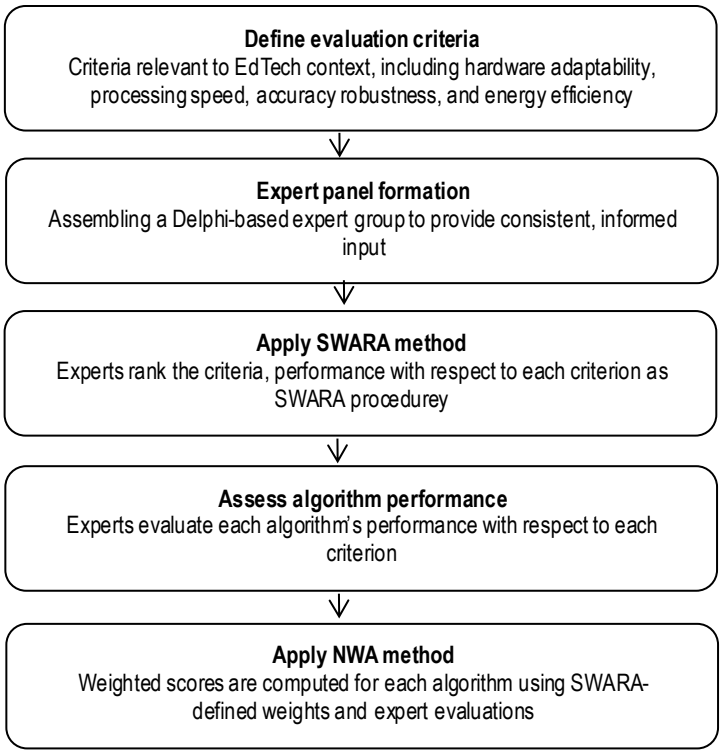
Define evaluation criteria
Criteria relevant to EdTech context, including hardware adaptability, processing speed, accuracy robustness, and energy efficiency
Expert panel formation
Assembling a Delphi-based expert group to provide consistent, informed input
Apply SWARA method
Experts rank the criteria, performance with respect to each criterion as SWARA procedurey
Assess algorithm performance
Experts evaluate each algorithm's performance with respect to each criterion
Apply NWA method
Weighted scores are computed for each algorithm using SWARA-defined weights and expert evaluations

Figure 1. Flowchart of the SWARA-NWA Hybrid Evaluation Framework
Source: Author's research

Steps of the SWARA Method

The SWARA method (Keršulienė et al., 2010) enables experts in the fields of education and artificial intelligence to express their judgments regarding the relative importance of predefined evaluation criteria.

1. Criteria Prioritization
   Experts rank the criteria in descending order of importance-from the most to the least significant. *(This is a qualitative step that precedes the quantitative analysis.)*

2. Relative Importance (s_j)
   Starting from the second criterion, experts estimate how much less important each criterion is in comparison to the previous one:
   S_j = relative importance of criterion *j* with respect to criterion *j–1*
   S_1 = 0 (since there is no preceding criterion for the first one)

3. Correction Coefficients
   Correction coefficients are calculated using the formula:
   $$k_j = s_j + 1 = s_j + 1,$$
   where $k_j = 1$ and j = 2, 3, … ,

4. Recalculated Weights (q_j)
   a) Raw weights (w_j):
   $$w_j = 1$$
   $$w_j = \frac{1}{k_2 \times k_3 \times \cdots \times k_j} \quad \text{for } j = 2,3,\ldots,n$$
   b) Normalized weights (q_j):
   $$q_j = \frac{w_j}{\sum_{j=1}^{n} w_j}$$

Criteria Definition and Expert Panel

For the purpose of this research, five criteria were defined as particularly relevant for educational settings:

- Computational efficiency (e.g., hardware requirements and startup speed),
- Processing speed (real-time execution performance),
- Pattern recognition accuracy (correct identification of handwriting, symbols, or educational elements),
- Robustness to noise (e.g., variations in lighting and background),
- Energy efficiency (power consumption in mobile or IoT environments).

To obtain reliable expert consensus, the Delphi method was employed, a widely recognized iterative technique for structured elicitation and aggregation of expert opinion under conditions of uncertainty and subjectivity (Hsu and Sandford, 2007).

Application of the NWA Method

Following the determination of criteria weights using the SWARA method, the Net Worth Analysis (NWA) approach (Zangemeister, 1976) was applied to aggregate performance values and compute the final score for each algorithm.

The overall score *S* for each algorithm *A* is calculated using the following formula:

$$S_i = \sum_{j=1}^{n} q_j \cdot v_i$$

Where:

- *S* represents the total score of algorithm *i*,
- q_j is the normalized weight of criterion *j* (from SWARA),
- v_j is the performance of algorithm *i* with respect to criterion *j*,
- *n* is the total number of criteria.

The performance values v_j were assigned by domain experts based on a review of prior studies, technical documentation, and practical use in educational tools.

Method Integration

The structured hybrid model ensures transparency and reproducibility in the evaluation process by combining subjective expert judgments with quantitative aggregation (Zellner et al., 2021). The integration of SWARA and NWA allows expert opinions to be transformed into numerical scores, facilitating objective comparison between alternatives while preserving flexibility in assessing qualitative dimensions.

This dual-layered approach provides a balanced interplay between analytical formalism and domain-specific expertise, which is particularly vital in educational contexts where evaluation criteria are often multidimensional and interdependent. The resulting output is a ranked list of algorithms according to their suitability for deployment within educational technology systems, enabling decision-makers to identify the most effective options aligned with the specific constraints and pedagogical needs of their institutions.

Evaluation Criteria

The effective integration of artificial intelligence into educational systems requires the careful selection of algorithms that are not only technically advanced but also aligned with pedagogical contexts and infrastructural constraints (Kaddouri et al., 2025). This study defines five key evaluation criteria that reflect the practical needs of educational institutions, particularly in the context of smart classrooms, mobile learning, and digital platforms with limited hardware capabilities. A similar approach is evident in studies on the integration of sensors and AI in smart classrooms, which emphasize the need to balance pedagogical, infrastructural, and technical dimensions (Mircea et al., 2023).

Computational Efficiency

Many primary and secondary schools, as well as educational institutions in rural or underdeveloped regions, lack access to advanced hardware infrastructure. Thus, one of the fundamental evaluation criteria is the algorithm's ability to operate on low-resource devices, such as older laptops, tablets, or cost-efficient IoT platforms.

Evaluation dimensions include:

- Memory efficiency (RAM, GPU usage),
- Minimal system requirements for deployment,
- Compatibility with mobile and embedded systems (e.g., Raspberry Pi, Android devices).

Algorithms that rely on complex deep neural networks with high inference costs may be unsuitable in educational environments where access to high-performance GPUs is limited.

Processing Speed

Many EdTech applications, especially those used for interactive learning, student monitoring, or automated assessment, require algorithms capable of real-time data processing. Latency in system response can negatively affect user experience, student engagement, and instructional effectiveness.

Assessment is based on:

- Average inference time per sample,
- Real-time processing capability of video streams,
- System responsiveness to user input in interactive applications.

Particular emphasis is placed on algorithms that maintain performance when handling live video or image sequences, which is essential for smart classroom scenarios and augmented reality (AR) applications.

Accuracy

AI algorithms in education must reliably recognize patterns specific to educational activities, including handwritten text, mathematical expressions, student gestures, diagrams, and physical objects used in STEM instruction.

This criterion refers to:

- Ability to accurately classify and segment relevant educational elements,
- Reduction of false positives and false negatives,
- Reliability in evaluating student work.

Accuracy is measured through both technical performance metrics and practical deployments in real-world educational scenarios. Explainability and transparency remain crucial, especially when AI systems influence pedagogical or administrative decisions. Though not limited to education, Spalević et al. (2024) highlight the importance of explainable AI in sensitive systems, a principle that equally applies to the classroom environment.

Robustness to Environmental Noise

Educational environments, particularly mobile learning contexts, often lack controlled lighting conditions. A tablet camera used in a hallway, playground, or brightly lit classroom may capture low-quality images. Therefore, it is essential that algorithms remain stable and accurate under variable conditions.

This criterion includes:

- Resistance to changes in lighting (e.g., overexposure, shadows),
- Ability to extract relevant features from images with complex backgrounds,
- Robustness when handling noise and degraded input quality.

Robust algorithms offer greater flexibility and ensure consistent reliability in everyday teaching scenarios.

Energy Efficiency and Sustainability

Modern education increasingly relies on mobile and IoT technologies. In smart classrooms, devices such as interactive boards, cameras, sensors, and student-owned equipment often depend on battery power or limited energy sources.

The following aspects are particularly valued:

- Energy consumption during algorithm execution (e.g., on smartphones, tablets, or Raspberry Pi devices),
- Battery life under continuous operation,
- Suitability for "green computing" initiatives in education.

Energy efficiency is regarded as a critical sustainability metric, both from an economic perspective and in terms of environmental responsibility, including the reduction of CO_2 emissions.

Case Study

To ensure that the evaluation of AI algorithms for educational purposes yields relevant and applicable results, a case study was conducted involving a panel of experts specializing in educational technology and the application of artificial intelligence in education. Expert judgment constitutes a fundamental component of the SWARA methodology, as both the weights of the evaluation criteria and the performance assessments of algorithms are grounded in professional expertise and consensus.

Selection and Profile of Experts

For the purposes of this study, a panel of seven experts was assembled, each with substantial experience across different domains of educational technology.

The selection criteria for expert inclusion were as follows:

- A minimum of five years of professional experience in the development or implementation of EdTech solutions, or in teaching within the fields of information technology and computer science;
- Active involvement in research or development of AI applications in education;
- Proficiency in computer vision, adaptive learning systems, or smart classroom technologies.

The composition of the expert panel was as follows:

- 2 university professors with expertise in artificial intelligence and practical experience in higher education instruction,
- 2 EdTech software engineers involved in the development of adaptive learning and assessment platforms,
- 1 researcher in the field of human-computer interaction and student behavior analysis,
- 1 computer science teacher with practical experience in applying AI tools in classroom settings,
- 1 education policy specialist focused on digital transformation and inclusive education initiatives.

This interdisciplinary composition enabled the evaluation process to integrate diverse perspectives, ranging from instructional and practical viewpoints to research-oriented and strategic dimensions.

Evaluation Procedure and Consensus Building

The evaluation was conducted in two phases using the Delphi method, allowing for iterative consensus development while preserving the anonymity of individual expert responses.

Phase one involved individual assessment of the following:

- The relative importance of each of the five predefined evaluation criteria (via the SWARA method),
- The performance of each algorithm according to the specified criteria (via the NWA method).

Experts used a five-point scale (where 5 indicated the highest possible value) and were encouraged to provide additional qualitative comments and recommendations.

In phase two, aggregated results from the first round were presented to the experts, who were then given the opportunity to revise their initial evaluations in light of observed trends. This procedure resulted in a high level of consensus without the influence of dominant individuals. All responses remained anony-

mous, and communication was facilitated through an online platform specifically designed for structured survey-based expert elicitation.

Data Validation and Reliability

To ensure data reliability, several control measures were implemented:

- Consistency checks among expert responses (standard deviation < 0.6 in the majority of cases),
- Cross-referencing with published literature and technical documentation for each algorithm,
- Technical briefings that included concise presentations and practical examples of each algorithm's potential use in educational scenarios.

Based on expert assessments and the validated dataset, the SWARA method was applied to calculate the criterion weights, followed by the application of the NWA method to derive the final score and ranking for each algorithm.

Results and Discussion

This section presents and interprets the findings obtained through the application of the hybrid SWARA–NWA model for evaluating nine artificial intelligence algorithms within the context of educational technology. The analysis was conducted in three stages: determining the weights of evaluation criteria, assessing algorithm performance according to each criterion, and calculating the total scores to establish a final ranking.

Criterion Weights

Table 1 displays the results derived from the SWARA method, used to determine the relative importance of five predefined evaluation criteria in the context of EdTech applications. Based on the input of seven experts in educational technology and AI implementation in education, "computational efficiency" was identified as the most significant criterion, receiving a subjective weight of 0.20 and a final normalized weight (q_j) of 0.250. This high value reflects the practical need for algorithms that can operate effectively on older computers, tablets, and low-performance devices within educational institutions.

Table 1. *SWARA-Based Weight Coefficients for Evaluation Criteria (Source: Author's research)*

Criterion	(Sj)	(Kj = Sj + 1)	(Wj)	(qj)
Computational efficiency	0.2	1.20	1	0.250
Processing speed	0.15	1.15	0.870	0.217
Pattern accuracy	0.12	1.12	0.776	0.194
Noise robustness	0.1	1.10	0.706	0.176
Energy efficiency	0.08	1.08	0.654	0.163

The second most important criterion, according to the experts, was "processing speed" (q_j = 0.217), as rapid system response is critical for user experience and instructional efficacy in interactive classrooms and adaptive platforms. "Pattern accuracy" was ranked third (q_j = 0.194), as it reflects the algorithm's ability to reliably recognize handwriting, symbols, diagrams, and other educational elements. The remaining two criteria, "robustness to noise" and "energy efficiency", received slightly lower final weights (0.176 and 0.163, respectively), though still recognized as relevant, particularly in mobile learning environments and scenarios with unfavorable lighting conditions.

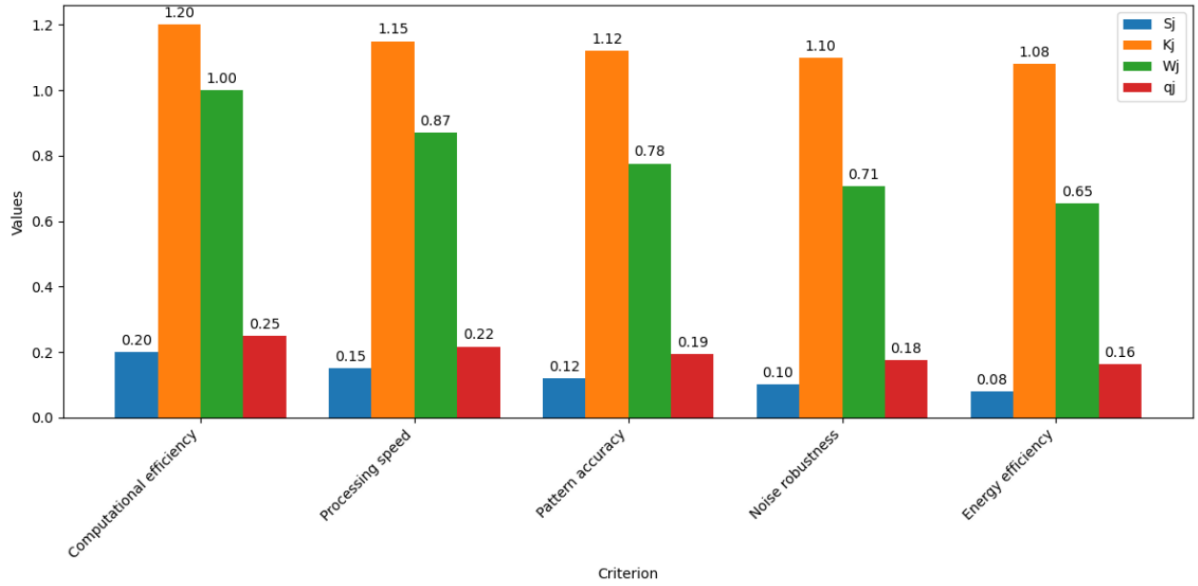

Figure 2. SWARA Criterion Evaluation Overview (Source: Author's research)

These results clearly indicate that experts favored algorithms enabling broad and inclusive application across diverse educational settings, consistent with the strategic aims of digital transformation in education.

Algorithm Performance Scores

Table 2 presents expert-assigned performance scores for the nine evaluated algorithms across all five criteria. These scores served as input values for the NWA phase, allowing for a detailed comparison prior to score aggregation.

Table 2. *Expert Performance Scores of AI Algorithms According to Evaluation Criteria (Source: Author's research)*

Algorithm	Computational Efficiency	Processing Speed	Pattern Accuracy	Noise Robustness	Energy Efficiency
Fast R-CNN	0.193	0.245	0.213	0.245	0.245
U-Net	0.193	0.213	0.245	0.213	0.213
DeepLab	0.178	0.213	0.245	0.213	0.213
MobileNet	0.245	0.213	0.193	0.193	0.213
ResNet	0.213	0.193	0.160	0.245	0.245
Binary Segmentation	0.245	0.245	0.213	0.178	0.160
YOLO	0.213	0.245	0.193	0.193	0.193
FCN	0.193	0.193	0.178	0.213	0.178
EfficientDet	0.245	0.160	0.160	0.160	0.160

The analysis shows that Fast R-CNN received the highest scores in nearly all categories, particularly in processing speed, robustness, and energy efficiency (0.245 each). Although not the lightest in terms of hardware requirements, its score of 0.193 for computational efficiency suggests acceptable resource demands.

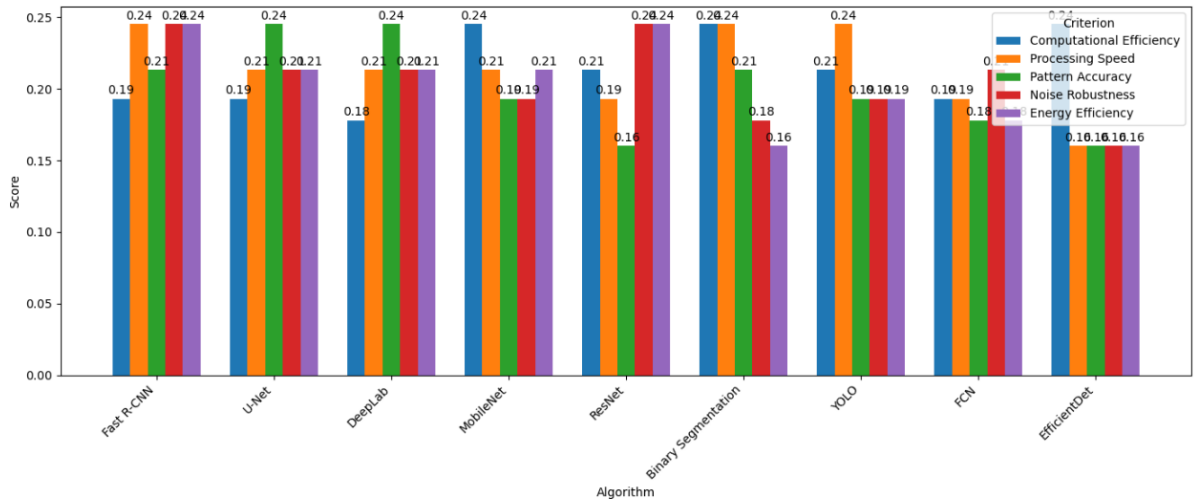

Figure 3. Algorithm Evaluation Across Criteria (Source: Author's research)

U-Net and DeepLab excelled in pattern recognition accuracy (0.245), making them particularly suitable for educational tasks requiring precise interpretation of visual content, such as diagrams and handwritten assignments.

MobileNet performed strongly in computational efficiency (0.245) and energy balance (0.213), rendering it well-suited for BYOD (Bring Your Own Device) strategies and mobile classrooms.

Interestingly, industrially successful models such as ResNet and EfficientDet performed relatively poorly on education-specific criteria. EfficientDet, in particular, received the lowest scores across almost all dimensions, suggesting that its deployment in education would require significant optimization. Binary Segmentation, although very fast (0.245), underperformed in terms of robustness (0.178) and energy efficiency (0.160), limiting its utility in energy-constrained or dynamic environments.

Final Results

Table 3 presents the final NWA scores obtained by applying the weights from Table 1 to the expert scores from Table 2. The algorithms are ranked from 1 to 9 according to their overall suitability.

Table 3. *Final NWA Scores and Ranking of AI Algorithms (Source: Author's research)*

Algorithm	Total Score	Rank
Fast R-CNN	1.141	1
U-Net	1.077	2
DeepLab	1.062	3
MobileNet	1.057	4
ResNet	1.056	5
Binary Segmentation	1.041	6
YOLO	1.037	7
FCN	0.955	8
EfficientDet	0.885	9

Fast R-CNN achieved the highest total score (1.141), affirming its overall adaptability to the requirements of educational technology. It offers a favorable balance between speed, robustness, and energy efficiency, with reasonable scalability.

U-Net (1.077) ranked second due to its high segmentation accuracy and solid performance across other criteria. It is especially promising for tasks such as automatic evaluation of handwritten work and visual analysis of student responses.

DeepLab (1.062) came in third, characterized by high precision and robustness, making it suitable for AR/VR applications in education.

MobileNet (1.057) and ResNet (1.056) had nearly identical total scores. The former is recommended for mobile applications and low-power environments, while the latter performs reliably in unstructured settings such as outdoor or field-based learning.

The remaining algorithms, FCN, Binary Segmentation, YOLO, and EfficientDet, showed limitations across multiple criteria. While not inherently unsuitable, their deployment would require targeted adaptation, hybrid integration, or use in narrowly defined tasks with specific performance requirements.

Unlike previous studies that employed MCDM methods to select e-learning platforms, curricula, or teaching strategies, this research focuses on evaluating specific computer vision algorithms within educational contexts. For instance, Toan et al. (2021) applied a hybrid AHP–COPRAS model for selecting e-learning systems, and Keshavarz-Ghorabaee et al. (2018) used SWARA and AHP for evaluating digital teaching tools. Marinović et al. (2025) employed the PIPRECIA method to optimize operating system selection in schools. Compared to these approaches, the proposed SWARA–NWA framework enables direct evaluation of AI algorithms based on education-specific criteria such as computational efficiency, robustness to environmental noise, and operability on low-end hardware. This methodological distinction makes the model particularly suitable for decision support in real-world EdTech scenarios, especially in resource-constrained educational settings.

Research Limitations

While the hybrid SWARA–NWA model offers a structured and transparent framework for evaluating AI algorithms in educational environments, several limitations must be acknowledged that may influence the scope and applicability of the findings:

1. Subjectivity of expert evaluations – The methodology relies on expert judgment to assign weights and assess algorithm performance, introducing a level of subjectivity.
2. Limited number of experts – The panel consisted of seven experts, which is appropriate for the Delphi method, yet a larger sample would enhance statistical validation and understanding of assessment variability.
3. Theoretical rather than experimental validation – Algorithm evaluation was based on technical documentation and expert analysis, without direct benchmarking on real educational datasets.
4. Restricted set of evaluation criteria – Although the five selected criteria were carefully chosen for EdTech relevance, real-world decision-making may require consideration of additional factors such as implementation costs, technical support availability, user digital literacy, and alignment with local educational policies.
5. Focus on computer vision algorithms only – While the selected algorithms are among the most commonly used in AI applications, the study does not address other domains such as natural language processing (NLP), recommendation systems, or intelligent tutoring systems, which are also highly relevant in modern education.

Conclusion

This study presents a hybrid multi-criteria decision-making model based on the SWARA and Net Worth Analysis (NWA) methods for the evaluation of artificial intelligence algorithms in the context of educational technology. The primary objective was to provide a transparent and systematic framework that supports educational institutions, IT teams, and policy makers in selecting the most appropriate AI algorithms tailored to the specific needs of EdTech applications.

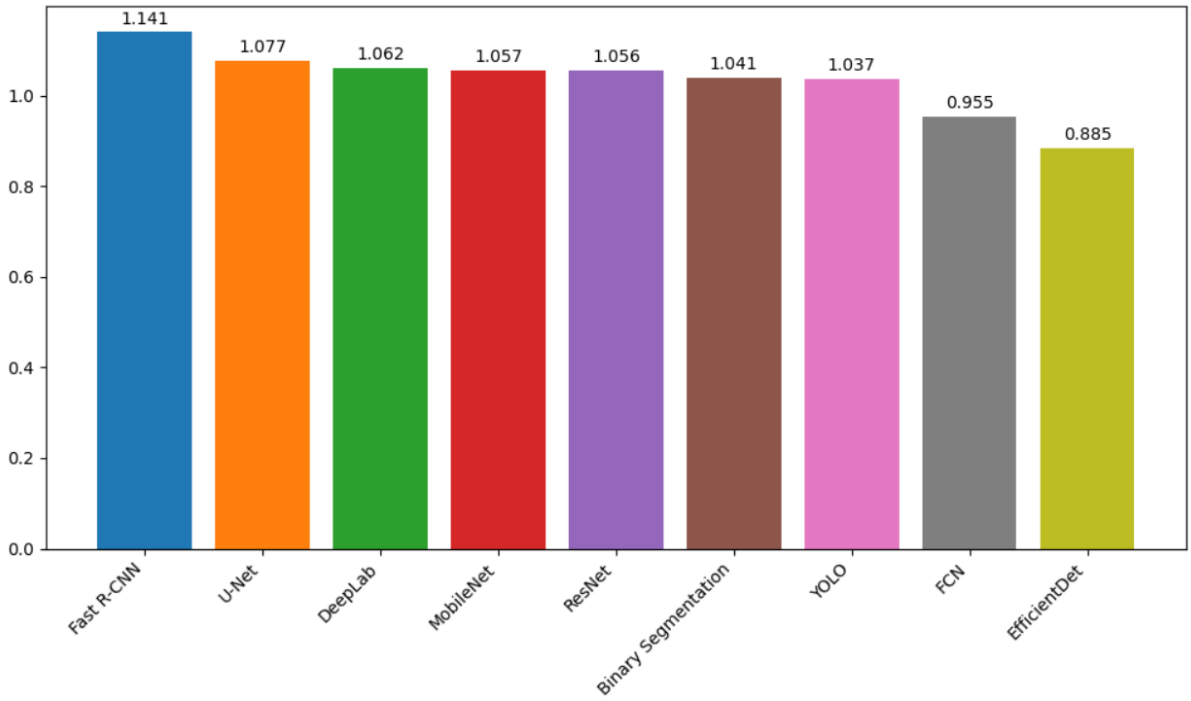

Figure 4. Graphical Representation of the Final Results of the Hybrid Model (Source: Author's research)

The evaluation focused on computer vision algorithms and incorporated five key criteria relevant to educational scenarios: computational efficiency, processing speed, pattern recognition accuracy, robustness to lighting and background disturbances, and energy efficiency. The SWARA method was applied to determine the relative importance of each criterion based on expert assessments, while the NWA method was used to aggregate the performance scores of each algorithm and generate a final ranking, as illustrated in Figure 2.

The findings indicate that Fast R-CNN emerged as the most suitable algorithm for widespread deployment in educational systems, owing to its balanced performance across all criteria. U-Net and DeepLab stood out for their superior accuracy in visual segmentation, making them particularly well-suited for specialized educational tasks that involve complex visual pattern analysis. MobileNet, due to its lightweight architecture and energy efficiency, proved to be an ideal solution for mobile and resource-constrained environments, particularly within the context of inclusive education in underserved regions.

Recommendations for Future Research

Based on the findings and identified limitations of the present study, we propose the following directions for future research:

- Empirical validation of the model – Future studies should incorporate experimental testing of the algorithms using real-world educational datasets to complement and verify the theoretical assessments.
- Expansion of the algorithm pool – Include algorithms from other areas of AI, such as natural language processing (NLP), recommender systems, and classification models.
- Incorporation of additional evaluation criteria – Such as cost-efficiency, availability of open-source implementations, compliance with educational standards, and required teacher training.
- Application of alternative MCDM methods – Including AHP, PIPRECIA, or fuzzy MCDM approaches, to compare outcomes and test the robustness of the proposed model.
- Involvement of end users (teachers and students) – Through interviews, surveys, and pilot testing to enrich the results with insights drawn from real-life educational experiences.

The proposed model represents a significant methodological advancement toward the rationalization and formalization of decision-making processes related to the adoption of AI-based technologies in education. In the current era of accelerated digital transformation, where educational institutions are striving to balance innovation with systemic constraints, it becomes evident that decision-making based on intuition or fragmented information is no longer sufficient. What is needed is a robust, transparent, and

multi-criteria framework that facilitates the inclusion of diverse stakeholder groups, from teachers and learners to IT specialists and educational authorities.

The core value of this model lies in its ability to reconcile the technological potential of artificial intelligence with the practical needs and constraints of the educational sector. In doing so, it enables the formulation of policies and practices that are not only technically sophisticated, but also socially responsible, pedagogically justified, and systemically sustainable. Ultimately, such tools contribute to the development of educational strategies that are equitable, scalable, and effective, approaches in which AI is not seen as an end in itself, but as a means of enhancing the overall quality of education.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The data supporting the reported results in this study are contained within the article itself.

Institutional Review Board Statement

Not applicable.

Author Contributions

Nikola Gligorijević: Conceptualization, Investigation, Methodology, Formal analysis, Writing – original draft. Nikola Gligorijević is the first author and led the research design and implementation of the hybrid SWARA-NWA model.; Sonja Đukić Popović: Validation, Methodology, Writing – review & editing, Data curation.; Vojkan Nikolić: Software, Data curation, Visualization. Dejan Viduka: Resources, Supervision.; Stefan Popović: Writing – review & editing, Visualization, Formal analysis. All authors have read and agreed to the published version of the manuscript.

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STEM-Focused Science Identity Questionnaire Based on the PISA 2025 Framework: Rasch Model Validation

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Abstract: This study developed and validated a Science Identity Questionnaire for secondary school students based on the PISA 2025 framework using a Rasch model analysis. The questionnaire aimed to measure key aspects of science identity, including science capital, attitude toward science, and environmental awareness. A total of 496 students (200 males and 269 females) from various Indonesian provinces participated. The data were analyzed using the Rasch model to examine item validity, reliability, and demographic bias. The results indicated that the questionnaire fit the Rasch model excellently, confirming its validity, with Outfit and Infit Mean Square values within acceptable ranges. Reliability analysis yielded person and item reliabilities of 0.72 and 0.99, respectively. No significant bias was detected between male and female students or between urban and rural respondents. These findings support using this tool to assess science identity and its role in promoting long-term STEM engagement. This instrument can inform interventions that aim to foster inclusive science education.

Keywords: *Science Identity, PISA 2025 Framework, Rasch Model, STEM.*

Introduction

A strong science identity is a critical driver of students' engagement, motivation, and achievement in science (Zhu and Luo, 2024; Belova et al., 2024). Students who perceive themselves as competent and recognized in science are more likely to persist in STEM pathways and pursue related careers (Young et al., 2025; Lockhart et al., 2024). However, systemic inequities often limit this development, particularly among underrepresented groups such as females and students from low-income or rural backgrounds (Rodriguez et al., 2024; Mahasneh et al., 2024). Addressing these disparities requires robust instruments capable of capturing science identity as a multidimensional construct that bridges personal background, affective engagement, and educational outcomes (Latip, 2024).

Science identity is therefore a critical link between students' personal backgrounds and their educational outcomes (Young et al., 2025; Rodriguez et al., 2024). For previously underrepresented groups, science identity can help address systemic inequalities by establishing a sense of belonging to the science community and increasing their passion for achieving success in science (Lockhart et al., 2024; Mahasneh et al., 2024). Educational programs that foster science identity, such as experiential learning, mentorship, and engagement in real research, have been shown to be effective in improving students' academic processes and career goals (Morell et al., 2025; Hsu and Frausto, 2024).

Science Identity and Educational Outcomes

The development of science identity has far-reaching implications for students' academic achievement and career aspirations (Zhu and Luo, 2024; Belova et al., 2024). Students with a strong science

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identity demonstrate higher levels of engagement and confidence in science subjects, which translates into improved academic performance and a deeper conceptual understanding of scientific principles (Zhu and Luo, 2024; Morell et al., 2025). This connection is particularly important for fostering persistence in Science, Technology, Engineering, and Mathematics (STEM) fields, as students who see themselves as capable science learners are more likely to pursue advanced studies and careers in science-related domains (Belova et al., 2024; Young et al., 2025).

Therefore, science identity serves as a critical mediator between students' personal backgrounds and their educational outcomes (Young et al., 2025; Rodriguez et al., 2024). In the case of historically underrepresented groups, science identity can help mitigate the impact of systemic inequities by strengthening their sense of belonging within scientific communities and enhancing their motivation to excel in STEM fields Lockhart et al., 2024; Mahasneh et al., 2024). Educational interventions that focus on enhancing science identity through experiential learning, mentorship, and authentic research opportunities have been shown to significantly improve students' academic trajectories and career intentions (Morell et al., 2025; Hsu and Frausto, 2024).

Science Identity in The PISA 2025 Framework

The Programme for International Student Assessment (PISA) plays a vital role in evaluating students' scientific literacy on a global scale (Latip, 2024). The PISA 2025 framework introduces a transformative approach by integrating science identity as a key component of scientific literacy, reflecting a broader understanding of what it means to be scientifically literate (Latip, 2024). The framework recognizes the importance of students' identities, values, and emotional connections to science (Deta et al., 2024).

This shift aligns with current educational trends that prioritize holistic learning outcomes (Sadler and Zeidler, 2009). Embedding science identity within the assessment criteria, PISA 2025 aims to evaluate not only students' knowledge and skills but also their engagement with socio scientific issues (SSI), environmental awareness, and their capacity to apply scientific reasoning in complex real-world contexts (Deta et al., 2024). This comprehensive approach is designed to foster a deeper connection between students and science, encouraging them to view themselves as active participants in scientific inquiry and decision-making (Latip, 2024).

The focus on science identity in PISA 2025 also reflects the growing consensus that students' affective engagement with science plays a critical role in their long-term STEM participation (Rodriguez et al., 2024; Mahasneh et al., 2024). Evaluating how students perceive their role in the scientific community and their ability to contribute to societal challenges, PISA 2025 seeks to promote lifelong engagement with science and enhance the inclusivity of STEM education (Latip, 2024; Young et al., 2025).

Developing a Science Identity Questionnaire Using The Rasch Model

Despite the increasing recognition of science identity as a crucial factor in STEM education, there remains a lack of robust instruments for measuring this construct (Mahasneh et al., 2024; Morell et al., 2025). Existing tools often rely on traditional psychometric methods, such as factor analysis, which may not fully capture the dynamic and multidimensional nature of science identity (Bhatti et al., 2023; Rodriguez et al., 2024). Ensuring the psychometric soundness of measurement instruments, including validity and reliability, is a critical step in educational research (Sawitri et al., 2024). Addressing this gap, this study leverages the Rasch model, a psychometric framework within Item Response Theory (IRT), in developing a Science Identity Questionnaire that aligns with the PISA 2025 framework (Bhatti et al., 2023; Latip, 2024).

The Rasch model offers several advantages for science identity measurement. It provides detailed item-level analyses, ensuring unidimensionality and enabling the development of instruments that yield reliable, objective, and cross-comparable results (Oktavianti and Aini, 2024; Bhatti et al., 2023). Measuring individuals' perceptions and responses is essential for understanding their engagement and identity within a specific context. Previous studies have highlighted how individual threat appraisals or perceptions can influence behavior and engagement (Sari and Adiati, 2023), providing useful insights for assessing science identity. This model has been successfully applied in educational contexts to assess constructs such as scientific literacy, career identity, and science process skills, demonstrating its versatility and effectiveness (Budi et al., 2024; Sunni et al., 2024).

Adapting the Rasch model to measure science identity, the study aims to capture key dimensions

of the construct, including students' perceptions of competence, recognition, and belonging in science (Lockhart et al., 2024; Young et al., 2025). The approach is expected to provide a more nuanced understanding of how science identity develops across diverse educational contexts and demographic groups (Rodriguez et al., 2023; Mahasneh et al., 2024).

Furthermore, the study aims to develop and validate a Science Identity Questionnaire for middle school students based on the PISA 2025 framework, using Rasch model-based validation and reliability analysis. Providing a robust measurement tool, the research seeks to enhance understanding of science identity and its role in shaping students' academic and career outcomes (Mahasneh et al., 2024; Young et al., 2025). Additionally, integrating the PISA 2025 framework, which emphasizes affective engagement, environmental awareness, and global competence, could contribute to a more holistic understanding of scientific literacy and its broader societal implications. Ultimately, the study aims to inform educational practices and policies that promote equitable and inclusive STEM education, thereby supporting the development of a diverse and capable STEM workforce (Latip, 2024; Mahasneh et al., 2024; Young et al., 2025).

Materials and Methods

The research instrument employed was a questionnaire developed based on the PISA 2025 framework. The questionnaire was designed to explore various aspects of students' science identity, encompassing three primary constructs: Science Capital, Attitudes Toward Science, and Environment. The instrument consists of 20 statements addressing epistemic beliefs, science capital, self-concept, self-efficacy, enjoyment of science, instrumental motivation, environmental awareness, environmental concern, and environmental agency. These statements were designed using a 4-point Likert scale: 1 (Strongly Disagree), 2 (Disagree), 3 (Agree), and 4 (Strongly Agree), excluding a neutral option to elicit clearer responses from students. The questionnaire items, along with their respective indicators, are presented in Table 1.

Table 1. *Questionnaire statements based on the PISA 2025 framework*

Construct	Aspect	Statement
Science Capital	Epistemic Beliefs	I believe that science is an effective way to understand the world. (**A1**)
		Scientific methods rarely provide real solutions to important problems. (**A2**)
	Access to Resources	I have access to sufficient science resources (such as books, laboratories, internet) to learn more about science. (**A3**)
		I find it difficult to understand some scientific concepts. (**A4**)
	Involvement in Science Activities	I often engage in scientific activities outside of school. (**A5**)
		I often discuss science with friends or family. (**A6**)
Attitude	Science Self-Concept	I feel I am good at learning science. (**B1**)
		I am not interested in working in science-related fields in the future. (**B2**)
	Self-Efficacy in Science	I believe that I can complete difficult science tasks. (**B3**)
		Q9) I feel uncertain about my ability in science. (**B4**)
	Enjoyment of Science	Q10) I get bored when studying science topics in school. (**B5**)
		I enjoy conducting scientific experiments. (**B6**)
	Instrumental Motivation	I study science because I think it is important for my future. (**B7**)
		I am unsure how knowledge of science will be useful for my career. (**B8**)
Environment	Environmental Awareness	I understand the importance of preserving the environment for our future. (**C1**)
		I feel that environmental issues are often exaggerated. (**C2**)
	Environmental Concern	I care about the impact of human activities on the environment. (**C3**)
		I don't think I need to contribute to environmental conservation. (**C4**)
	Environmental Agency	I am actively involved in activities aimed at protecting the environment. (**C5**)
		I am not sure I can make a significant impact on environmental conservation. (**C6**)

The questionnaire was verified by three experts to ensure that the structure and preparation of the instrument were organized systematically and logically, the content of the questionnaire was in accordance with the concept of scientific identity, and the language used was appropriate, easy to understand, and in accordance with the ability level of junior high school students. The three experts stated that the questionnaire was valid and reliable.

After that, the questionnaire that had been validated by experts was then disseminated to junior high school students throughout Indonesia through Google Form. The researcher distributed the Google Form link via email and WhatsApp messages to junior high school science teachers to distribute to students. So that every student gets the opportunity to become a sample in this study.

Participants

This study involved 469 junior high school students, including 200 males and 269 females. Of those students, 142 lived in urban areas, while 327 lived in rural areas. The students' ages ranged from 11 to 15 years old, in accordance with the target age range of the PISA 2025 framework. The students who completed the questionnaire were from several provinces: Banten, Jakarta, West Java, Central Java, East Java, East Kalimantan, West Sulawesi, Central Sulawesi, South Sulawesi, and West Sumatra.

Data Analysis Using The Rasch Model

The Rasch Model is a powerful tool for evaluating the validity and reliability of educational and psychological instruments. It provides a detailed analysis of item fit statistics, which are crucial for assessing how well items align with the model's expectations. This approach is particularly useful in educational settings, where it can help ensure that test items accurately measure the intended constructs, such as mathematical creative thinking or self-efficacy. The Rasch Model's ability to identify misfit items and persons enhances the precision of the instrument, making it a preferred choice for researchers aiming to develop robust assessment tools. Data analysis for Rasch model calibration and item fit statistics was conducted using WINSTEPS Version 5.7.1.0, which is specifically designed for item response theory (IRT) analysis and provides in-depth insights into item and person fit.

Instrument Validity and Item Fit Statistics

- **Item Fit Statistics:** The Rasch Model evaluates item fit using statistics such as Outfit Mean Square (MNSQ), and Outfit Z-standard (ZSTD). These statistics help determine whether each item on a test fits the expected model. For instance, items with MNSQ values between 0.5 and 1.5 and ZSTD values within the range of -2 to +2 are typically considered to demonstrate good fit (Soeharto, 2021).
- **Misfit Identification:** The Rasch Model can identify items or persons that do not fit the model, providing insights into potential biases or inconsistencies. Misfit items or respondents may indicate areas where the test could be improved, such as revising ambiguous items or addressing unintended interpretations (Fischer et al., 2021).

Reliability Testing

- **Reliability Scores**: The Rasch Model provides reliability scores for both items and persons, which indicate the consistency of the instrument. Person reliability reflects the consistency of respondents' answers, while item reliability assesses the stability of item difficulty across different samples. Reliability scores range from 0 to 1, with values above 0.80 generally considered high, indicating excellent reliability, values between 0.70 and 0.80 considered acceptable, and values below 0.70 indicating lower reliability (Qudratuddarsi et al., 2022; Soeharto, 2021).
- **Cronbach's Alpha:** This statistic is often used alongside the Rasch Model to assess internal consistency. High Cronbach's Alpha values, typically above 0.70, indicate that the items on the test reliably measure the same underlying construct. Studies on self-concept and self-acceptance have reported high Cronbach's Alpha values, further supporting the reliability of these instruments when used in conjunction with Rasch analysis (Latifah et al., 2024; Gunawan et al., 2023).

Results

Validity Analysis

Based on the results from the Rasch model analysis presented in Table 2, several important parameters were assessed to confirm the validity and fit of the instrument. The Outfit MNSQ values for both person and item are 1.05, respectively, which fall within the acceptable range of 0.5 to 1.5. These values indicate that the instrument fits the Rasch model well, suggesting that the items and respondents align with the model's expectations. Additionally, the Infit MNSQ values for person (1.03) and item (1.00) also fall within this range, further confirming that there is no significant misfit in how the instrument measures respondents' abilities and item difficulty.

The Outfit ZSTD values for both person and item are -0.3 and 0.7, meanwhile the Infit ZSTD values for person and item are -0.4 and -0.1, respectively, which are acceptable, indicating no substantial misfit in the model's application to both persons and items.

The instrument can achieve unidimensionality if the raw variance explained by the measure exceeds 30% (Soeharto, 2021; Chou and Wang, 2010; Linacre, 1998). The analysis confirmed that the instrument surpassed this minimum threshold, with a raw variance explained by the measure of 35.8%. This indicates that the instrument effectively explains a significant portion of the variance in the data, demonstrating its ability to measure the intended construct.

Table 2. *Summary of validity indices for person and item measures*

	Person	Item
Number	469	20
Mean	53.6	1257.6
SD	6.3	237.5
Outfit MNSQ	1.05	1.05
Infit MNSQ	1.03	1.00
Outfit ZSTD	-0.3	0.7
Infit ZSTD	-0.4	-0.1
	Raw variance by measure:	35.8%

Reliability Analysis

The reliability of the instrument was assessed using various metrics, as shown in Table 3, including person reliability, item reliability, and Cronbach's Alpha (α). These values were generated using WINSTEPS software. The person reliability is 0.72, which is within the acceptable range for Rasch analysis (values above 0.70 are typically considered acceptable). This indicates that the instrument is effective in differentiating between respondents with varying abilities. The item reliability is exceptionally high at 0.99, demonstrating excellent consistency in measuring item difficulty across the sample.

The Cronbach's Alpha for the test is 0.66, which is adequate but could be improved for better internal consistency. This value indicates that the test items generally measure the same underlying construct, though it may benefit from slight improvements in internal consistency to ensure stronger coherence among items.

The person separation index is 1.60, which is above the minimum threshold of 1.4, indicating that the instrument is able to distinguish between different levels of science identity among respondents. While this value is acceptable, an ideal separation index is closer to 2.0, suggesting that there is still room for improvement in separating respondents at the extreme ends of the ability spectrum.

The item separation index is 12.81, which is high, indicating that the items are well spread across different difficulty levels, effectively differentiating between the various levels of science identity. A higher separation value suggests that the instrument is well-designed to measure different levels of the construct.

Although the Cronbach's Alpha coefficient (0.66) is slightly below the conventional threshold of 0.70, this level remains acceptable for exploratory validation studies, particularly in multidimensional constructs such as science identity (Tavakol and Dennick, 2011). The multidimensionality of this questionnaire—which captures aspects of epistemic beliefs, self-efficacy, and environmental engagement—can naturally lower inter-item homogeneity without compromising construct validity. Future revisions will consider expanding and refining items in the self-concept and recognition sub-dimensions to further enhance internal consistency and content balance across domains.

Table 3. *Summary of reliability indices for person and item measures*

	Person	Item
Reliability	0.72	0.99
Separation	1.60	12.81
Cronbach's Alpha	0.66	

Person-Item Map

The Wright Map visually represents the relationship between respondents' abilities and item difficulty, according to the Rasch model (Soeharto and Csapo, 2022). On the left side of the map (Figure 1), person measures range from -3 to 5, illustrating the diverse ability levels of the respondents. Individuals with lower abilities are represented by negative values (-3, -2 and -1), indicating that they find most items difficult. Those around 0 have moderate abilities, while respondents with higher abilities, marked by positive values (from 1 to 5), are more likely to answer difficult items correctly. The majority of respondents are concentrated around the 0 mark, suggesting that most participants have moderate abilities, with fewer respondents at the extremes of the ability scale.

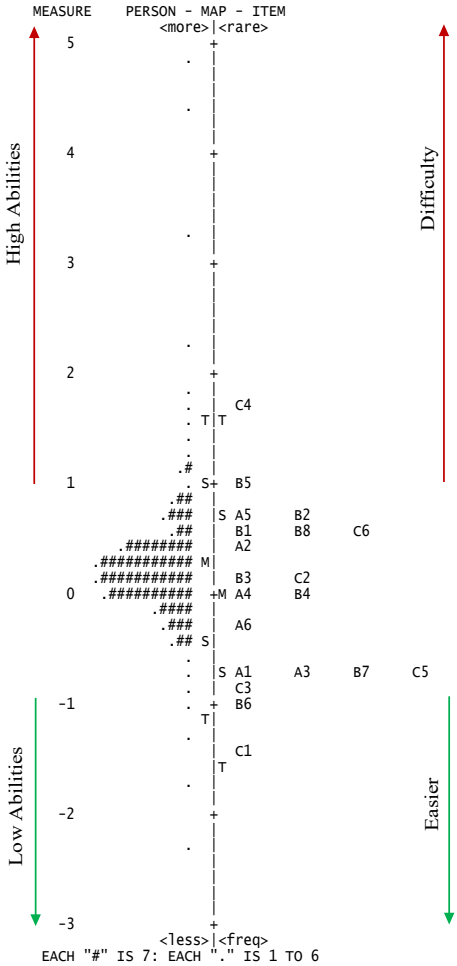

Figure 1. Person-item distribution in science identity measurement

On the right side of the map (Figure 1), item measures also span from -3 to 5. Items with negative values (-3, -2, and -1) are very difficult and are typically answered only by high-ability respondents. Items with values near 0 represent moderate difficulty, and those with positive values (from 1 to 5) are easier, often answered correctly by respondents with moderate abilities. This distribution of item difficulty ensures that the instrument captures a wide range of respondent abilities, from easy to difficult.

The vertical alignment of items in the Wright Map (Figure 1) further highlights that each item targets different aspects of science identity, with varying levels of difficulty. This design ensures that the instrument assesses a broad spectrum of abilities and provides a comprehensive measure of respondents' science identity engagement and capabilities.

Item Bias Based on Differential Item Functioning (DIF)

DIF According to Gender

A DIF analysis was conducted in this study to evaluate potential item bias between male and female respondents across all ability levels (Soeharto, 2021). DIF analysis compares participant responses based on gender for each item in the test, highlighting any differences in item difficulty (Khine, 2020). DIF is assessed using two criteria: statistical significance ($p < 0.05$) and DIF size, which is categorized as negligible, slight to moderate ($|DIF| \geq 0.43$ logits), and moderate to large ($|DIF| \geq 0.64$ logits) (Zwick et al., 1999).

Based on the DIF analysis, none of the items showed significant or moderate-to-large DIF. All items had DIF sizes below 0.43 logits, suggesting that there were no substantial differences in difficulty between male and female respondents (Figure 2). Therefore, no significant gender bias was detected, and the test can be considered fair for both male and female respondents, ensuring equal opportunities for both genders to perform well on the test.

This aligns with the broader discourse on minimizing gender bias in educational and psychological assessments. Addressing gender-based disparities and biases is critical for promoting equality and inclusivity (Huda et al., 2024). Ensuring that the Science Identity Questionnaire does not exhibit significant DIF based on gender strengthens its contribution to the development of unbiased educational tools that reflect students' abilities, engagement, and science identity without being influenced by demographic factors such as gender.

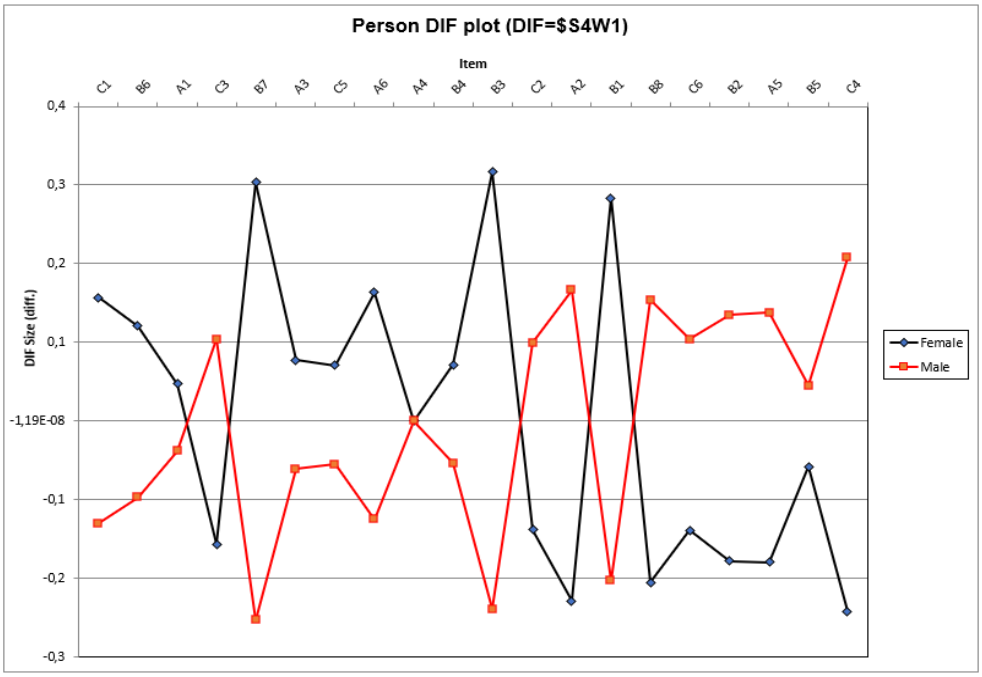

Figure 2. DIF based on gender

DIF According to Area

The results of the DIF analysis based on area (rural vs. urban) indicated that none of the items in the test displayed a significant DIF with a value ≥ 0.43 logits. This suggests that all the items fall within the

"negligible" DIF category, meaning the items did not exhibit substantial differences in difficulty between rural and urban respondents. As shown in Figure 3, the DIF sizes for all items are below 0.43 logits, confirming that there is no meaningful bias in how the test items function across the two areas. Therefore, the test appears to be fair and unbiased for respondents from both rural and urban areas, with no need for further adjustments based on geographical differences.

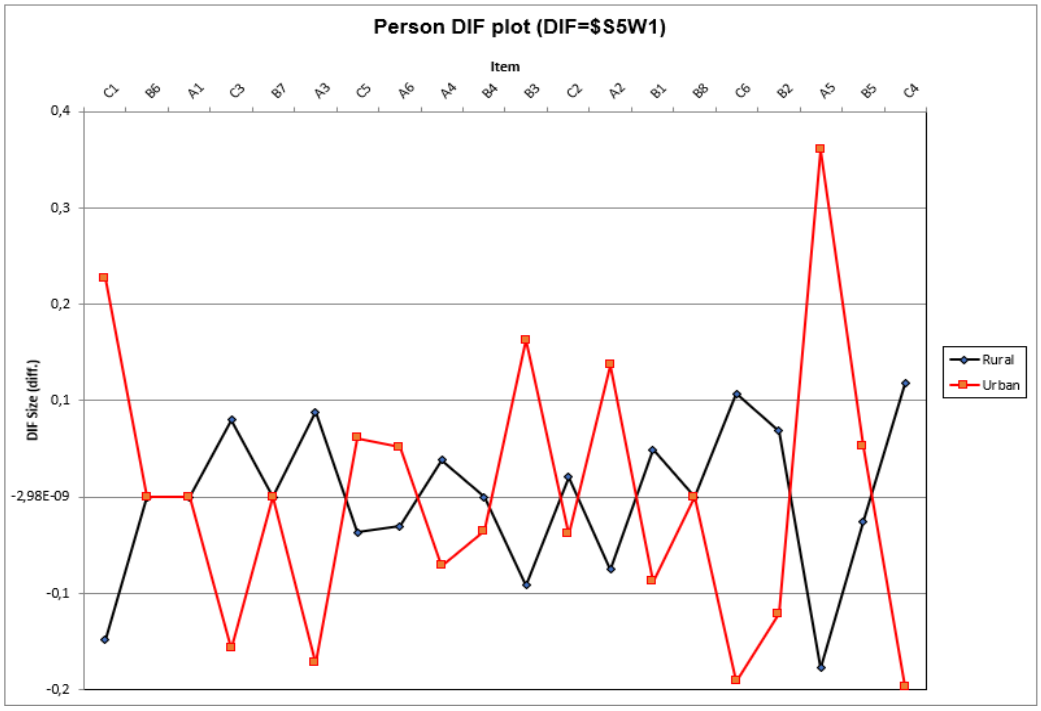

Figure 3. DIF based on area

Discussions

Summary of Main Findings

This study aimed to develop and validate the Science Identity Questionnaire based on the PISA 2025 framework, employing the Rasch model to measure students' science identity. The questionnaire was designed to capture three primary constructs: Science Capital, Attitudes Toward Science, and Environmental Awareness. The key findings derived from the analysis can be summarized as follows:

1. Instrument Validity and Model Fit: The item-fit analysis demonstrated that all questionnaire items fell within the acceptable range, indicating a good fit with the Rasch model (Soeharto, 2021). Specifically, the Outfit Mean Square (MNSQ) values for items and respondents were within the optimal range of 0.5 to 1.5, confirming that the instrument effectively differentiates students based on varying levels of science identity. This finding aligns with previous research that underscores the importance of developing psychometrically sound instruments for assessing multidimensional constructs like science identity (Mahasneh et al., 2024; Rodriguez et al., 2024). By employing the Rasch model, this study contributes to the growing body of evidence demonstrating that Rasch-based instruments provide reliable and nuanced measurements of complex psychological constructs, including self-efficacy, epistemic beliefs, and science engagement (Bhatti et al., 2023).
2. Reliability and Internal Consistency: The reliability analysis indicated that the instrument was robust, with person reliability of 0.72 and item reliability of 0.99. Although the Cronbach's Alpha value was 0.66, which is slightly below the ideal threshold of 0.70, it still reflects acceptable internal consistency. This suggests that while the test items measure related aspects of science identity, there is some room for improvement in enhancing item coherence. Several studies have highlighted that increasing the number of items measuring specific dimensions of identity, such as recognition and competence, could potentially enhance Cronbach's Alpha by improving internal consistency (Mahasneh et al., 2024;

Gunawan et al., 2023). Future refinements may involve expanding items related to key subdimensions of science identity, particularly those that may exhibit greater variability among respondents. The moderate internal consistency observed (α = 0.66) reflects the multidimensional nature of science identity, which integrates affective, cognitive, and contextual dimensions. In Rasch measurement theory, such variation does not necessarily indicate a weakness but rather supports construct coverage across diverse subdomains (Bhatti et al., 2023). Moreover, the alignment between the acceptable person reliability (0.72) and very high item reliability (0.99) suggests that the questionnaire's precision in estimating item difficulty is excellent, although respondent differentiation could still be optimized (Soeharto, 2021). These reliability indicators collectively affirm that the instrument is psychometrically robust, yet flexible enough for further refinement across cross-cultural and educational contexts.

3. Differential Item Functioning (DIF): The DIF analysis revealed no significant bias between male and female respondents or between students from urban and rural areas. This indicates that the questionnaire functions fairly and without bias across different demographic groups, making it an inclusive tool for assessing science identity. This finding contrasts with prior research that identified gender-based differences in science identity, particularly the tendency for female students to report lower self-efficacy and interest in STEM-related fields (Rodriguez et al., 2024; Lockhart et al., 2024). The absence of significant DIF in this study suggests that the instrument effectively captures science identity in a way that minimizes potential biases related to gender or geographic background. This is a critical consideration for promoting diversity and inclusion in STEM education, as it supports the development of equitable assessment tools that provide an accurate picture of students' engagement and potential across diverse contexts.

Implications for Educational Practice

The findings have important implications for educational practice and the measurement of science identity. The focus on science capital, attitudes toward science, and environmental awareness aligns closely with the PISA 2025 framework's emphasis on holistic scientific literacy (Latip, 2024). Addressing these dimensions allows the Science Identity Questionnaire to provide valuable insights that can guide the development of targeted interventions aimed at strengthening science identity, particularly for underrepresented groups such as female students and those from rural areas. Research has also highlighted the importance of designing contextualized assessment tools that embed test items in real-life situations, which can enhance both the validity and applicability of the instrument (Constantinou, 2024). Applying these principles in the Science Identity Questionnaire could improve its ability to capture students' perceptions and engagement with science, thereby contributing to a more comprehensive understanding of how science identity develops in diverse educational contexts.

Furthermore, the emphasis on epistemic beliefs, self-efficacy, and environmental awareness underscores the multidimensional nature of science identity, which has been linked to long-term STEM engagement and career aspirations (Mahasneh et al., 2024; Young et al., 2025). These dimensions are crucial for fostering students' confidence, sense of belonging, and motivation in STEM fields, thereby contributing to more equitable and inclusive STEM education. Capturing this multidimensionality requires an understanding of the potential heterogeneity among students, as different groups may engage with science in diverse ways. This aligns with findings from mixed Rasch model applications in educational research, where distinct respondent classes have been identified based on variations in cognitive strategies or test-taking behavior, providing deeper insights into latent traits and engagement patterns (Baghaei and Carstensen, 2013).

Given its alignment with the global PISA 2025 science framework, the Science Identity Questionnaire possesses strong potential for international use. Its multidimensional structure enables adaptation across different cultural and linguistic contexts while maintaining psychometric rigor. Cross-cultural validation could reveal how socio-cultural values influence students' recognition and belonging in science, supporting international benchmarking of science identity (Liu et al., 2023; Potgieter et al., 2022). Such cross-contextual insights would help refine educational policies and contribute to the global discourse on equitable STEM participation.

Limitations and Directions for Future Research

Although the Science Identity Questionnaire demonstrated strong validity and reliability, some limitations must be acknowledged. First, the Cronbach's Alpha value indicates that there is potential to improve the internal consistency of the questionnaire. Future studies could explore additional refinements to the items to enhance coherence and strengthen the instrument's psychometric properties. While this study primarily focused on the psychometric properties of the Science Identity Questionnaire using the Rasch model, future research could explore students' test-taking effort as an additional factor influencing response quality. Analyzing response time and the number of actions taken could provide deeper insights into student engagement and its impact on the validity of questionnaire data (Ivanova and Michaelides, 2023). Additionally, advanced response pattern detection methods could be considered in future studies to identify repetitive response patterns and improve data quality and validity (Gottfried et al., 2022).

Furthermore, this study focused on middle school students within the context of the PISA 2025 framework. Extending the research to other educational levels and international contexts could provide a broader understanding of how science identity develops across diverse populations and educational systems (Latip, 2024). Longitudinal studies could also explore the long-term impact of science identity on students' academic trajectories and career outcomes in STEM fields.

Conclusions

The Science Identity Questionnaire developed and validated in this study has proven to be a reliable and valid tool for measuring science identity in middle school students, based on the PISA 2025 framework. The Rasch model analysis confirmed that the instrument effectively differentiates students with varying levels of science identity, with strong item and person reliability, though minor refinements could enhance its internal consistency. Additionally, the absence of significant Differential Item Functioning (DIF) across gender and geographic background indicates that the questionnaire functions equitably, making it an inclusive tool for diverse populations. These findings highlight the instrument's potential for providing nuanced insights into students' engagement, self-efficacy, and sense of belonging in science, essential factors for fostering long-term STEM participation. Ultimately, the questionnaire aligns with global educational goals by integrating affective dimensions such as environmental awareness and epistemic beliefs, offering valuable applications in educational assessment, intervention, and policy development aimed at promoting diversity and inclusivity in STEM fields. Beyond its national context, this study offers a foundation for future comparative research across ASEAN and OECD countries, where science identity serves as a core indicator for inclusive STEM education. By combining psychometric precision with global relevance, the Science Identity Questionnaire can serve as a reference instrument for international educational assessment aligned with PISA 2025 goals.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Institutional Review Board Statement

This study was conducted in strict accordance with the ethical standards of research involving human participants and in line with the principles of the Declaration of Helsinki. The research protocol was reviewed and approved by the Institutional Review Board (IRB) / Ethics Committee of [University of Trunojoyo Madura] (Approval Number: [B/9895/UN46.4.1/PT.01.04/2025], Date of Approval: [November 9th, 2025]).

Author Contributions

Conceptualization, S.E.S.M., S.Z., and R.A.; methodology, S.E.S.M.; software, I.I..; formal analysis, S.E.S.M. and S.S.; investigation, S.E.S.M, S.Z., R.A., and I.I; writing original draft preparation, S.E.S.M. and S.Z.; writing review and editing, S.S. and R.A. All authors have read and agreed to the published version of the manuscript.

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Application of Statistical Models for the Analysis of Data Obtained from Continuous Assessment of Students in Higher Education

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Abstract: This paper presents the findings of a study aimed at exploring students activities during lectures and exercises. The research was conducted through basic population of students at the University "St. Kliment Ohridski" – Bitola, in academic years from 2015 to 2023. The data obtained from the continuous checking of the students' knowledge, which refer to: attendance and activity in lectures and exercises, preparation of seminar papers, independent (home) work, completed or realized projects / programs, as well as from the colloquium grades, are the basis for the application of linear statistical models that will be realized through descriptive, correlation and regression analysis, factor analysis and statistical inference. In this way, information is obtained from a series of indicators that will serve the professors to take appropriate corrective actions, in order to improve and better create their teaching and educational process. As a result, it is expected to obtain better results that are of interest to students and higher education institutions, in terms of increasing the quality and efficiency of the teaching and learning process in higher education.

Keywords: *Statistical Models, Statistical Inference, Database of Statistical Data, Continuous Assessment (ECTS), Higher Education.*

Introduction

The problem of research in this paper consists in finding a way to improve the results in the educational process in higher education institutions by applying statistical models, with appropriate software support. Namely, the problem of the research can be expressed by the question: "Does the application of statistical models in the analysis of the statistical data obtained from the continuous assessment of students enable the improvement of the teaching and learning process in higher education institutions?" Solving this problem will be possible only if a comprehensive statistical analysis (descriptive, correlational, regression, factorial) and statistical inference (statistical hypothesis testing) is made of the available data related to the continuous examination of students' knowledge in higher education (Williamson, Bayne and Shay, 2020).

The main goal of the research should enable the identification, discovery and statistical conclusion of the interaction that exists between the results of the different modalities of continuous assessment and the final results achieved in the continuous assessment of students in higher education (Yang and Ge, 2022).

Specific research objectives should enable: obtaining insights from the review and identification of the state of the results of continuous assessment through the methods of descriptive statistics; gaining insights into the interaction between the different modalities and the final results of continuous assessment, through correlation and regression analysis; statistical inference for the results of the continuous assessment through the parametric testing of statistical hypotheses and determination of the components of the factors that are significant for the achieved results in the continuous assessment through factor analysis (Wong and Li, 2020).

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Many authors emphasise the importance of continuous assessment (CA) of students. M. Combrinck and M. Hatch (Combrinck and Hatch, 2012) emphasises that students perceived that their learning is improved and that is evident that many students' experiences of CA were positive.

D. Playfoot, L.L. Wilkinson, and J. Mead (Playfoot, Wilkinson, and Mead, 2023) in their work reports a series of studies that assessed the performance of students on continuous assessment components from two courses in an undergraduate psychology programme. The studies described in this paper set out to examine whether students with additional learning needs might be disadvantaged when continuous assessment tests are incorporated into courses and as result of this research there appears to be no such disadvantage (Teeroovengadum, Nunkoo, Gronroos, Kamalanabhan and Seebaluck, 2019).

Y. R. Rincón, A. Munárriz, A. M. Ruiz (Rincón, Munárriz, and Ruiz, 2024) proposes a new approach of continuous assessment of a formative nature, aimed at achieving meaningful learning with lower stress levels.

Author H.A. Bencsik (Bencsik, 2017) communicates the results of the research concerning the maintenance of young students' attention during higher education classes and their motivation for cooperation. At the same time. The results confirmed that the teaching methods do not affect the students' openness. Their willingness to cooperate and their attitudes towards teamwork (Spitzig and Renner, 2022).

One of the process of continuous assessment of students is also evaluating lecturers by students. In this regard, D. D. Trung, B. Dudić, D. V. Duc, N. H. Son and A. Mittelman (Trung, Dudić, Duc, Son, and Mittelman, 2024) emphisises that the current landscape of higher education, the quality of teaching plays a crucial role in supporting the comprehensive development of students. Authors also focuses on constructing a lecturer ranking system, particularly in the context of a specific course through the evaluation process from students.

For this research very important is the use of linear models which M. Kutner, C Nachtsheim, J. Neter, and W. Li (Kutner, Nachtsheim, Neter, and Li, 2004) present in detail (the most important linear statistical models and their application possibilities).

According to (Bowman, 2012) quantitative meta-analysis is very useful, yet an underutilized technique for synthesizing research findings in higher education. He emphasizes that meta-analysis scientists have concluded that standardized regression coefficients applied to higher education represent an appropriate metric for effect size and that linear modeling provides an efficient method for conducting meta-analytic research (Morales, Salmerón, Maldonado, Masegosa and Rumí, 2022).

Also, according to (Tüzüntürk, 2015) the importance of using parametric and nonparametric statistical methods is inevitable for many scientific branches in the scientific world, especially for the quality of services in education. At the same time, it has great significance for personal development and performance, for the success of an institution, as well as for the development of the country.

The authors R. Januškevičius and D. Pumputis (Romanas and Dalius, 2011) consider the most common inaccuracies and errors when using statistical methods that are applied in educational research, especially related to the definition of the population or sample. In doing so they propose recommendations on how to avoid the mentioned inaccuracies and errors as well as an example of real statistical research in the real research of education (Abbas, 2020).

Materials and Methods

Materials and methods are the second section of an IMRAD paper. Its purpose is to describe the experiment in such retail that a competent colleague could repeat the experiment and obtain the some or equivalent results. Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

For solving the defined research problem, the research strategy case study (correlation study, survey research) is suitable. Namely, in the research from the basic population of students at the University "St. Kliment Ohridski" - Bitola, using a case study as a sample, students from the second year of the Faculty of Economics in Prilep, from all study programs, in the subject of statistics for economists in academic years 2014/2015, 2015/2016, 2016/2017, 2017/2018, 2018/2019, 2019/2020, 2020/2021, 2021/2022 and 2022/2023, that is, from 2015 to 2023 .

This should enable obtaining a series of answers to the following questions: Is there a difference in the results of continuous assessment in the first and second colloquium? Is there a difference in the

results of continuous assessment in the first (second colloquium) achieved by students from different study programs? Does the presence of students at classes and exercises affect the results of colloquia? Does the activity of students in teaching and exercises affect the results of colloquiums? Does the activity (attendance) of students in teaching and exercises affect the results of seminars?

Of course, a series of indicators for the average grades from the colloquiums (for example, by study programs), the average final grade, the average variability of the grades, the laws of probability, the distribution functions and the symmetry or asymmetry of the distribution of the continuous assessment results are also obtained here (Smeds, 2022). All this after academic years with appropriate comparative analysis and understanding of development tendencies. Also, with the survey research, answers should be obtained for questions related to the quality of teaching, the relationship with the students, as well as the evaluation of the students.

The application of survey statistics is observed using a representative sample (students of the second year of study in the subject of statistics for economists) for sufficiently significant time periods of recorded valid data (Castillo-Manzano, Castro-Nuño, López-Valpuesta, Sanz-Díaz and Yñiguez, 2024).

Based on these data, statistical processing was performed using statistical methods: descriptive statistics (average values, standard deviations, coefficients of variation), correlation and regression analysis (linear, simple and multiplicative), factor analysis (based on a survey of students), statistical inference, that is, testing of statistical hypotheses using the parametric ANOVA test (Luan and Tsai, 2021).

The data on the results of the continuous assessment of students in higher education are recorded in mandatory databases that should be operated by the subject teacher according to the rules for continuous checking and recording of the results achieved from the first cycle of studies at the University “St. Kliment - Ohridsk” - Bitola. That data is continuously recorded with all changes up to the final results of the continuous assessment, and then archived.

The research is carried out in the final part of the semester through a previously constructed survey questionnaire that is filled out by students who are regular at classes and exercises. Also, important data from the continuous assessment (attendance, activity, seminar/project assignments and colloquiums) are collected at the end of the semester for all registered students from the second year of study (Clemons and Jance, 2024). The overall procedure of creating and applying a statistical model for the analysis of data obtained from the continuous assessment of students in higher education is presented in Figure 1.

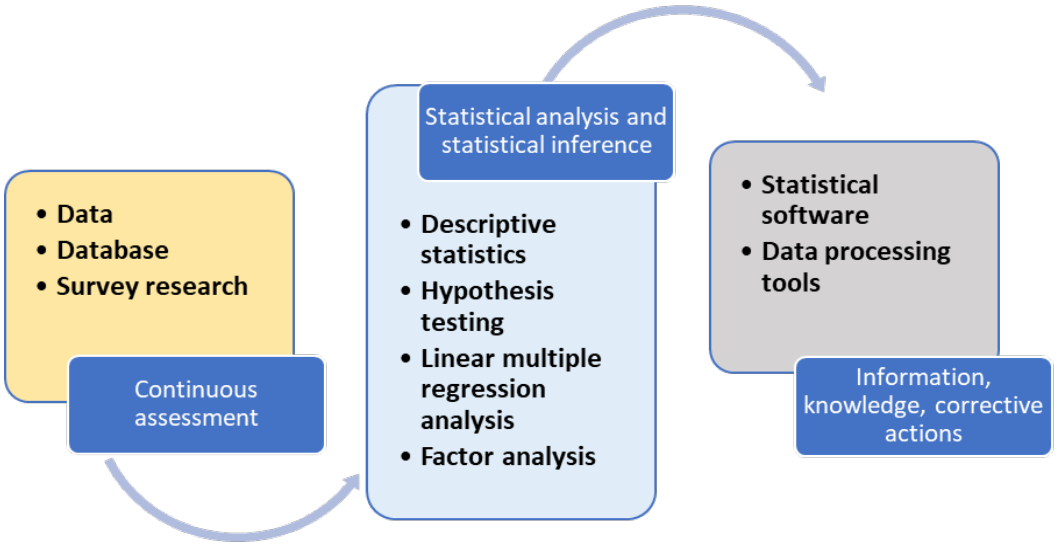


Figure 1. Statistical models for the analysis of data obtained from continuous assessment.

Data on colloquiums, attendance, activity, the creation of seminar works or research tasks, as well as data from survey research, are created in a special database for continuous assessment and are subject to statistical processing and analysis through the use of: descriptive statistics, correlational and regression analysis, factor analysis and statistical inference. Data analysis tools in Microsoft Excel, SPSS or other statistical software and applications are used in the processing. The goal is to obtain information and knowledge about the success of the education process, as a basis for taking corrective actions to continuously improve that success.

The multiple regression model for this research can be represented by the following formulation:

$$\hat{y}_1 = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 ,$$

where:

$\hat{y}_1$ General assessment;
x_1 - Average points from colloquiums;
x_2 - Attendance at classes and exercises;
x_3 - Teaching activity and exercises;
x_4 - Preparation of a seminar paper (projects, programs, etc.).

Based on the above-defined model, simple regression models can be defined and a regression analysis can be performed on them, whereby relevant indicators for the quantitative interaction of the variables of interest will be obtained.

Hypothetical research framework

Based on the subject and objectives of the research, the following basic hypothesis can be defined, as well as the auxiliary hypotheses derived from it:

Basic hypothesis: The results of the additional activities in the continuous knowledge test do not affect the final grade in the continuous assessment.

Auxiliary hypotheses:

- The results of the colloquia do not affect the final grade in the continuous assessment.
- Students' attendance at classes and exercises does not affect the final grade in continuous assessment.
- Activity in teaching and exercises does not affect the final grade in continuous assessment.
- Completion of project assignments or term papers does not affect the final grade in continuous assessment.

The processing and analysis of the data, the subject of this research, is quite convenient to realize, considering that the entire record of the continuous evaluation is created in a database in Microsoft Excel. Namely, Data Analysis is used as a tool for statistical data processing and Microsoft Excel with all available statistical procedures, in order to solve the problem of decision-making: descriptive statistics, correlation and regression analysis, parametric ANOVA testing, etc. The convenience of importing data from Microsoft Excel into the data editor in the statistical package SPSS is also used, where there is an opportunity for additional processing and analysis with other statistical methods, non-parametric tests, factor analysis, etc.

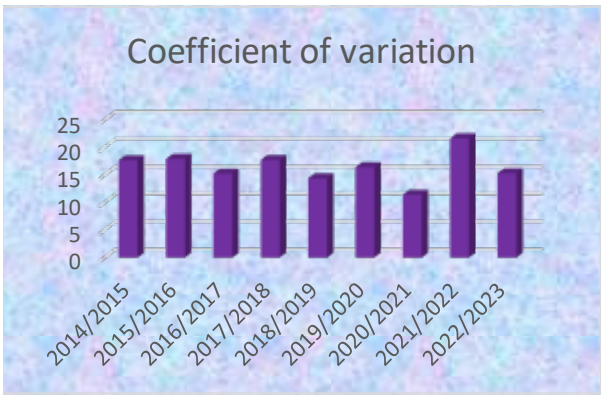
Results

By applying descriptive statistics to the recorded data for continuous evaluation, a series of information is obtained regarding the average grades, the average variability of the grades (Table 1), the asymmetry of the distribution of the grades, as well as the possibility of generalization through interval evaluation with an appropriate confidence threshold. All this is made possible by using Data Analysis in Microsoft Edge, (See Table 2).

Table 1. *Statistics from processed data for continuous assessment of students in the subject statistics for economists according to school years*

Academic year	Average grade	Standard deviation	Coefficient of variation
2014/2015	7,52	1,33	17,67
2015/2016	8,04	1,44	17,92
2016/2017	7,59	1,16	15,26
2017/2018	8,27	1,47	17,72
2018/2019	6,83	0,98	14,39
2019/2020	7,94	1,30	16,42
2020/2021	8,5	0,972	11,43
2021/2022	8	1,73	21,65
2022/2023	8	1,225	15,31

The average grade from the continuous assessment in 5 out of 9 school years is 8 or above 8. Only in the 2018/2019 academic year we have the lowest average grade, i.e. an average grade below 7. (Table 1 and Figure 2). The greatest variability in grades, expressed by the coefficient of variation, was observed in the school year 2021/2022, and the lowest in the academic year 2020/2021. (Table 1 and Figure 3).



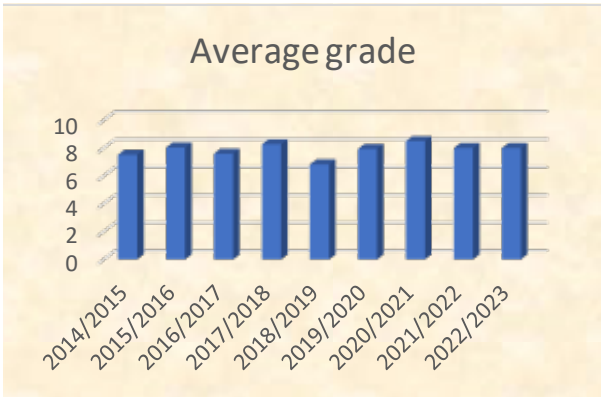


Figure 2. Average final grades across academic years. *Figure 3. Coefficient of variation.*

There is also the possibility to calculate and compare the average grades and their variability between the different study programs, the first and second colloquium and so on.

This provides information on success and corrective actions to be taken to improve that success.

Based on the processed data related to the subject of research in this paper, the following information presented in Table 1 is obtained.

Table 2. *Descriptive statistics on the additional activities of students in the subject statistics for economists in the respective academic years*

Academic year	Total students	Insufficient attendance (%)	Insufficient activity (%)	Not interested in seminary (%)	Passed through colloquiums (%)
2014/2015	181	16,02	60,22	75,14	45,86
2015/2016	149	12,08	36,91	77,85	35,57
2016/2017	95	17,89	53,68	86,32	35,78
2017/2018	90	4,44	51,11	78,89	41,11
2018/2019	72	19,44	81,94	84,72	8,33
2019/2020	95	25,26	73,68	92,61	18,95
2020/2021	60	13,33	58,33	90,00	16,67
2021/2022	46	30,43	84,78	80,43	23,91
2022/2023	18	5,55	72,22	72,22	27,78

The following can be seen from table 2 and figure 4:

- The number of students registered in the subject statistics for economists continuously and significantly decreases in the observed time period, almost by 4 times, as of the academic year 2021/2022. From the academic year 2022/2023, the subject statistics for economists is optional for the accounting and auditing, banking and finance and international business study programs. (Table 2 and Figure 5).
- Not all registered students attend classes and exercises on the subject of statistics for economists. 30.43% of the registered students in the academic year 2021/2022 do not have or have received 1 point for attending classes and exercises. Also, a significant percentage, more than a quarter, or 25.26% of the registered students, are doing so in the 2019/2020 academic year. Of course, there are various reasons for this that are not the subject of discussion in this paper. There is a greater attendance at classes and exercises in the academic years 2017/2028 and 2022/2023. (Table 2 and Figure 6).
- The data concerning the inactivity of students in all observed academic years are worrying and an increase in the development tendency is observed. Except for the academic year 2015/2016, in all the others it can be seen that more than half of the students do not show activity in teaching and exercises. That percentage is even over 80. (Table 2 and Figure 7).
- The interest in producing seminar papers on the subject of statistics for economists is a concern. Namely, more than ¾ of the students in all academic years are not interested in making a seminar paper. At most or less than 10% of students are interested in making a seminar paper in the academic years 2019/2020 and 2021/2022. From the graphic display in Figure 8, one can see the consistency in that lack of interest.
- The pass rate, i.e. the percentage of passed students through colloquiums, decreases until the academic year 2018/2019, so that percentage starts to grow again continuously. (Table 2 and Figure 9).

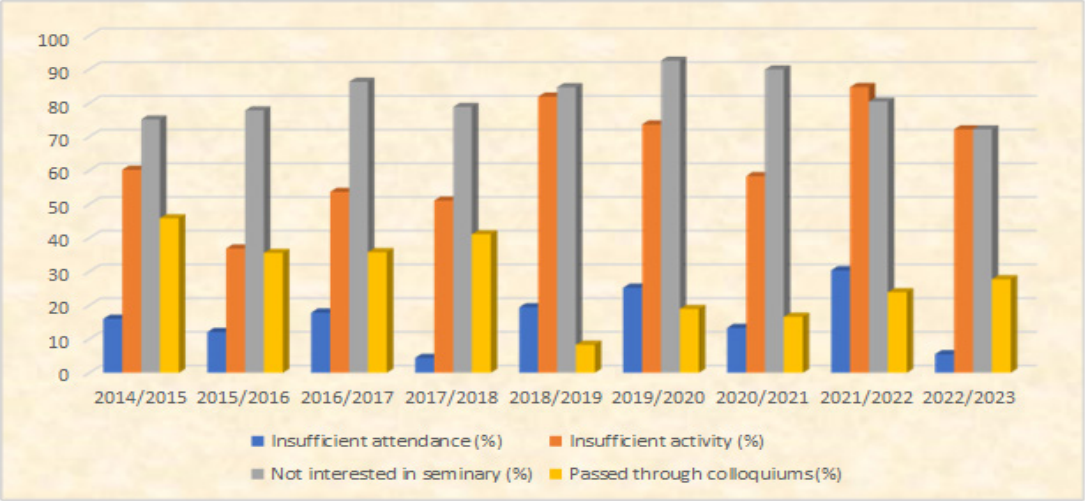


Figure 4. Percentage participation/non-participation of students for the additional activities of students in the subject statistics for economists by academic years

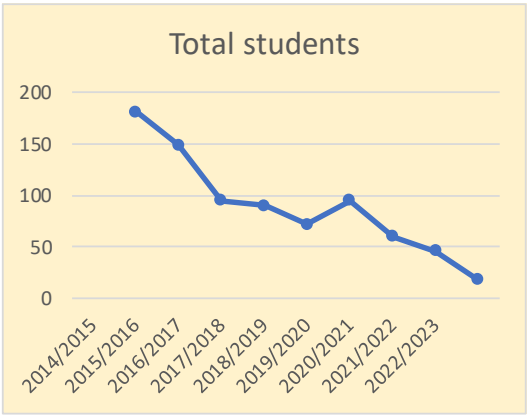


Figure 5. The number of students

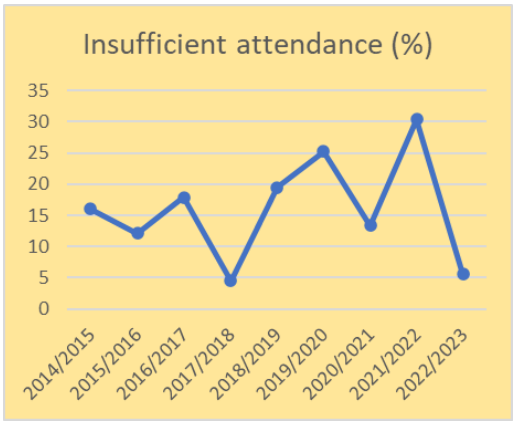


Figure 6. Classes attendance

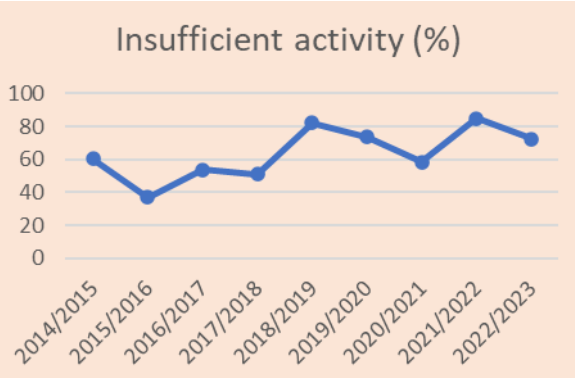


Figure 7. Classes activity

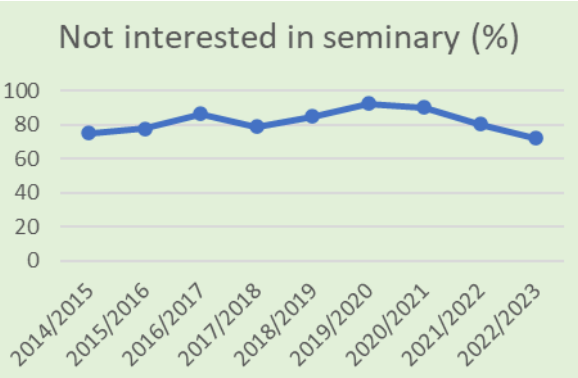


Figure 8. The interest in producing seminar papers

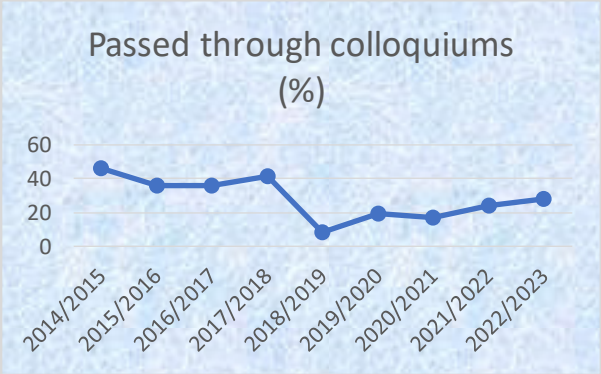


Figure 9. Colloquiums pass rate

Based on the data from table 2 that refer to the additional activities: attendance at classes and exercises, activity at classes and exercises, and preparation of seminar papers, the following hypotheses can be defined:

H1: There is no difference in the percentage participation in the additional activities of the students according to the different academic years

H2: There is no difference in the percentage of students' participation in extracurricular activities compared to the different modalities of extracurricular activities.

To test the above-defined hypotheses, we apply the parametric ANOVA test with two factors and multiple modalities. We get the following results (Table 3).

Since the calculated value of the F variable (2.493614) is lower than the theoretical value of the F variable which is 2.591096, we accept H1 and statistically conclude that there is no difference in the percentage participation in the additional activities of the students according to the different academic years.

We come to the same conclusion by comparing the measured value of p, which is 0.057022, which is greater than the theoretical value p=0.05.

Since the calculated value of the F variable (128.6174) is greater than the theoretical value of the F variable which is 3.633723, we reject H2 and statistically conclude that there is a significant difference in the percentage participation in the additional activities of the students according to the different modalities of extracurricular activities. We come to the same conclusion by comparing the measured value of p, which is approximately equal to 0, which is lower than the theoretical value p=0.05.

Table 3. *Anova: Two-Factor without Replication*

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
2014/2015	3	151.38	50.46	945.2368
2015/2016	3	126.84	42.28	1103.051
2016/2017	3	157.89	52.63	1171.493
2017/2018	3	134.44	44.81333	1415.437
2018/2019	3	186.1	62.03333	1362.576
2019/2020	3	191.55	63.85	1206.477
2020/2021	3	161.66	53.88667	1484.38
2021/2022	3	195.64	65.21333	912.1408
2022/2023	3	149.99	49.99667	1481.63
Insufficient attendance (%)	9	144.44	16.04889	71.83606
Insufficient activity (%)	9	572.87	63.65222	245.8493
Not interested in seminary (%)	9	738.18	82.02	46.8371

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	1618.258	8	202.2822	2.493614	0.057022	2.591096
Columns	20866.92	2	10433.46	128.6174	1.38E-10	3.633723
Error	1297.922	16	81.1201			
Total	23783.1	26				

If the basic multiple regression model is implemented for all academic years, the following indicators are obtained for the quantitative interactions of the variables of interest (Table 4).

Table 4. shows a very strong relationship between the final grade and the points obtained from the colloquiums, the presence of classes and exercises, the activity of classes and exercises and preparation of seminar papers. This relationship is also confirmed by the high values of the coefficients of determination.

Table 4. *Quantitative indicators of the interaction of variables in the general linear multivariate regression model.*

Academic year	Multiple R	Adjusted R Square	Standard Error	F-variable	p- value
2014/2015	0.9997	0.9995	0.3109	38906.95	0,0000
2015/2016	0.9999	0.9997	0.2008	63449.68	0,0000
2016/2017	0.9994	0.9986	0.4572	6163.435	0,0000
2017/2018	0.9999	0.9998	0.2352	37945.25	0,0000
2018/2019	0.9999	0.9999	0,0001	95829,15	0,0000
2019/2020	0.9834	0.9582	2.6511	109.82	0,0091
2020/2021	0.9684	0.9024	2.8074	26.43	0,0003
2021/2022	0,9999	0,9997	0.0001	97546.32	0,0000
2022/2023	0,9999	0,9998	0,0001	98238.49	0,0000

Also, for all academic years, it can be seen that the calculated values of the F-variable are greater than the corresponding theoretical values, that is, all the calculated p-values are lower than the theoretical value p=0.05. In all cases, that is, for all academic years, the hypothesis that there is no difference in the influence of grades from colloquiums, attendance, activity, the preparation of seminar papers, and the final grade is rejected. So there is a statistically significant difference in the influence of all modalities of additional activities and colloquium grades on the final grade. Or rather they have a different impact.

If we realize the simple regression models, that is, the separate impacts of the success of the colloquia and each modality of additional activities separately on the final grade, we will get the following results:

Table 5. *Quantitative indicators of the interaction of colloquium grades and the final grade*

Academic year	Multiple R	Adjusted R Square	Standard Error	F-variable	p- value
2014/2015	0.9326	0.8681	4.9208	540.61	0,0000
2015/2016	0.9452	0.8913	4.6255	427.18	0,0000
2016/2017	0.9349	0.8701	4.5063	222.11	0,0000
2017/2018	0.9387	0.8779	5.2644	266.95	0,0000
2018/2019	0.9297	0.8609	5.5079	254.79	0,0000
2019/2020	0.9552	0.9075	3.9426	187.38	0,0000
2020/2021	0.8018	0.6071	5.6326	17.997	0,0017
2021/2022	0.9574	0.9090	5.5590	120.87	0,0000
2022/2023	0.9235	0.8160	5.3159	23.18	0,0086

In Table 5, through the values of the correlation coefficients, a very strong relationship between the colloquium grades and the final grade can be seen. That strong interaction is also represented by the high values of the coefficients of determination. Also, for all school years it can be seen that the calculated values of the F-variable are greater than the corresponding theoretical values, that is, all the calculated p-values are lower than the theoretical value p=0.05. This means that, for all cases, that is, for all academic years, the hypothesis that colloquium grades do not affect the final grade is rejected. So, the grades from the colloquiums have a significant impact on the final grade.

Table 6. *Quantitative indicators of the interaction of the attendance of classes and exercises and the final grade*

Academic year	Multiple R	Adjusted R Square	Standard Error	F-variable	p- value
2014/2015	0.3826	0.1358	12.5945	13.89	0,0004
2015/2016	0.5732	0.3154	11.6060	24.95	0,0000
2016/2017	0.1021	0.0104	12.6324	0.34	0,5657
2017/2018	0.5628	0.2978	12.6237	16.69	0,0002
2018/2019	0.4892	0.2203	13.0408	12.59	0,0010
2019/2020	0.1168	0.0136	13.2267	0.25	0,6239
2020/2021	0.2003	0.0401	9.2337	0.42	0,5325
2021/2022	0.5757	0.2706	15.7386	5.45	0,0395
2022/2023	0.1511	0.0228	13.6972	0.09	0,7750

In table 6, through the values of the correlation coefficients, it can be seen that in certain academic years (2014/2015, 2015/2016, 2017/2018, 2018/2019 and 2021/2022) there is a significant relationship between the attendance of classes and exercises and the final grade , and while in some academic years (2016/2017, 2019/2020, 2020/2021 and 2022/2023) the presence of classes and exercises has a weak influence on the final grade - this is also seen from the insignificant value of the coefficients of determination. Also, for the corresponding academic years, it can be seen that the calculated values of the F-variable are greater than the corresponding theoretical values, i.e. calculated p-values are lower than the theoretical value p=0.05, and for the others they are higher than the theoretical value of p=0.05. This means that in some academic years, the hypothesis that the attendance of classes and exercises does not affect the final grade is rejected (that is, attendance has a significant impact on the final grade), and in other academic years, the hypothesis that the attendance of classes and exercises does not affect the final grade is accepted. on the final grade (meaning attendance does not affect the final grade).

Table 7. *Quantitative indicators of the interaction of class activity and exercises and the final grade*

Academic year	Multiple R	Adjusted R Square	Standard Error	F-variable	p- value
2014/2015	0.5658	0.3117	11.2402	38.13	0,0000
2015/2016	0.6267	0.3809	11.0370	32.99	0,0000
2016/2017	0.2693	0.0435	12.2297	2.50	0,1236
2017/2018	0.6832	0.4520	11.1517	31.52	0,0000
2018/2019	0.6964	0.4721	10.7304	37.67	0,0000
2019/2020	0.3068	0.0438	12.6756	1.87	0,1883
2020/2021	0.6756	0.4020	6.9487	8.40	0,0159
2021/2022	0.8489	0.6950	10.1776	28.34	0,0002
2022/2023	0.7660	0.4835	8.9069	5.680672	0,0757

In table 7, through the values of the correlation coefficients, it can be seen that in certain academic years (2014/2015, 2015/2016, 2017/2018, 2018/2019, 2020/2021 and 2021/2022) there is a significant relationship between the activity of teaching and exercises and the final grade, and while in some academic years (2016/2017, 2019/2020 and 2022/2023) the activity of classes and exercises has a weak influence on the final grade - this can be seen by the insignificant value of the coefficients of determination. Also, for the corresponding academic years, it can be seen that the calculated values of the F-variable are greater than the corresponding theoretical values, that is, the calculated p-values are less than the theoretical value p=0.05, and for the rest they are greater than the theoretical value p =0.05. This means that in some academic years the hypothesis that the activity in classes and exercises does not affect the final grade is rejected (that is, the activity has a significant impact on the final grade), and in other academic years the hypothesis that the activity in classes and exercises does not affect the final grade is accepted. grade (meaning the activity does not affect the final grade grade).

Table 8. *Quantitative indicators for the interaction of preparation of the seminar and the final grade*

Academic year	Multiple R	Adjusted R Square	Standard Error	F-variable	p- value
2014/2015	0.7569	0.5676	8.9095	108.62	0,0000
2015/2016	0.7860	0.6103	8.7560	82.44	0,0000
2016/2017	0.6868	0.4552	9.2299	28.57	0,0000
2017/2018	0.7514	0.5525	10.0775	46.68	0,0000
2018/2019	0.6782	0.4464	10.9889	34.06	0,0000
2019/2020	0.5890	0.3118	10.7531	9.61	0,0062
2020/2021	0.6111	0.3108	7.4603	5.96	0,0348
2021/2022	0.8956	0.7842	8.5609	44.60	0,0000
2022/2023	0.9615	0.9056	3.8067	49.00	0,0022

In Table 8, through the values of the correlation coefficients, it can be seen that in all academic years there is a significant relationship between the preparation of a seminar paper and the final grade. It can also be seen from the values of the coefficients of determination. Also, for all academic years it can be seen that the calculated values of the F-variable are greater than the corresponding theoretical values, that is, the calculated p-values are less than the theoretical value p=0.05. This means that for all academic years, the hypothesis that the preparation of seminar papers does not affect the final grade is rejected, that is, it is statistically concluded that the preparation of the seminar paper has a significant impact on the final grade. If we include in the regression model the independent variables expressed through all modalities of additional activities, that is, attendance at classes and exercises, activity at classes and exercises and preparation of seminar papers, then we get the following results from the interaction with the final grade.

Table 9. *Quantitative indicators of the interaction of additional activities and the final grade*

Academic year	Multiple R	Adjusted R Square	Standard Error	F-variable	p- value
2014/2015	0.7906	0.6107	8.4529	43.88	0,0000
2015/2016	0.8263	0.6634	8.1385	35.15	0,0000
2016/2017	0.6988	0.4371	9.3819	9.54	0,0001
2017/2018	0.8208	0.6450	8.9756	23.41	0,0000
2018/2019	0.7856	0.5870	9.4915	20.42	0,0000
2019/2020	0.7102	0.4115	9.9443	5.43	0,0091
2020/2021	0.7799	0.4613	6.5952	4.14	0,0480
2021/2022	0.9021	0.7518	9.1813	13.11	0,0012
2022/2023	0.9720	0.8618	4.6077	11.39	0,0000

In Table 9, through the values of the correlation coefficients, it can be seen that in all academic years there is a significant or very strong relationship between the additional activities and the final grade. It can also be seen from the values of the coefficients of determination. Also, for all academic years it can be seen that the calculated values of the F-variable are greater than the corresponding theoretical values, that is, the calculated p-values are less than the theoretical value p=0.05. This means that for all academic years, the hypothesis that the additional activities do not affect the final grade is rejected, that is, it is statistically concluded that the additional activities have a significant impact on the final grade.

Significant information about the quality of the teaching process is also obtained from a continuous survey of students, which refers to the teaching staff, using appropriate response modalities of the type: 5- yes, completely agree, 4- mostly agree, 3- I hesitate, 2- I mostly disagree, 1- no, I don't agree at all. Questions related to the teacher are defined as variables shown in Table 10.

Table 10. *Questions related to the teacher defined as variables*

Variable	Meaning	Variable	Meaning
SPRN	readiness to implement teaching	DAFZ	expands knowledge of the subject
PPI	commitment and the ability to provoke interest among students	RPFC	realizes a planned fund of lessons
KSMN	using modern methods of teaching work	OSODL	provides appropriate basic and additional literature
MS	knows how to motivate and involve students in the teaching process	PST	applies modern technologies
SDA	stimulates additional activities	ODK	open and available for consultation
LKO	has a personal culture and relationship	OO	allows objective assessment
IK	exams / colloquiums are with questions within the subject program	OIZ	the assessment is a reflection of the knowledge and achievement of the students

At the beginning, it is tested whether the data in the model are suitable for the application of factor analysis. We do that with Kaiser-Meyer-Olkin Measure of Sampling Adequacy.

Table 11. *Kaiser-Meyer-Olkin Measure of Sampling Adequacy.*

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,790
Bartlett's Test of Sphericity	Approx. Chi-Square	439,996
	df	91
	Sig.	,000

KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) for the analyzed model is 0.790, which shows that the data in the model are suitable for factor analysis. It is also confirmed by the significance

of the Chi-Sguare test for 91 degrees of freedom. Factor analysis is used to process the survey data. At the same time, the basic information from the answers presented through descriptive statistics such as average values of the answers and average variabilities of the answers are presented in Table 12.

Table 12. *Average values and average variabilities of students' answers*

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
SPRN	4,90	,325	114
PPI	4,63	,584	114
KSMN	4,37	,744	114
MS	4,56	,625	114
SDA	4,74	,625	114
DAFZ	3,71	,948	114
RPFC	3,80	,979	114
OSODL	4,46	,766	114
PST	4,08	,970	114
LKO	4,77	,533	114
ODK	4,80	,551	114
IK	4,63	,834	114
OD	4,59	,577	114
OIZ	4,71	,528	114

From Table 12, it can be seen that the students, through their answers, mostly agree that the teacher contributes to the realization of a quality and correct teaching process. If each question is analyzed, then the teacher should introduce additional activities that will serve to increase and expand the knowledge of the subject. The students mostly differ in their answers regarding the realization of the planned fund of classes, and they mostly agree that the teacher is adequately prepared for the realization of the teaching. We apply principal components factor analysis. In doing so, we get them Communalities (Table 13):

Table 13. *Communalities*

Communalities

	Initial	Extraction
SPRN	1,000	,731
PPI	1,000	,587
KSMN	1,000	,430
MS	1,000	,607
SDA	1,000	,576
DAFZ	1,000	,608
RPFC	1,000	,656
OSODL	1,000	,482
PST	1,000	,662
LKO	1,000	,449
ODK	1,000	,556
IK	1,000	,477
OD	1,000	,701
OIZ	1,000	,654

Extraction Method: Principal Component Analysis.

Table 14. *Extraction of the factors affecting the level of the teaching process*

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,412	31,512	31,512	4,412	31,512	31,512
2	1,609	11,493	43,005	1,609	11,493	43,005
3	1,105	7,892	50,897	1,105	7,892	50,897
4	1,050	7,502	58,399	1,050	7,502	58,399
5	,977	6,975	65,374			
6	,852	6,088	71,462			
7	,732	5,227	76,690			
8	,701	5,007	81,697			
9	,627	4,480	86,177			
10	,511	3,650	89,828			
11	,471	3,367	93,195			
12	,362	2,588	95,783			
13	,317	2,264	98,048			
14	,273	1,952	100,000			

Extraction Method: Principal Component Analysis.

Four factors explain 58.399% of the variability in the level of the teaching process.

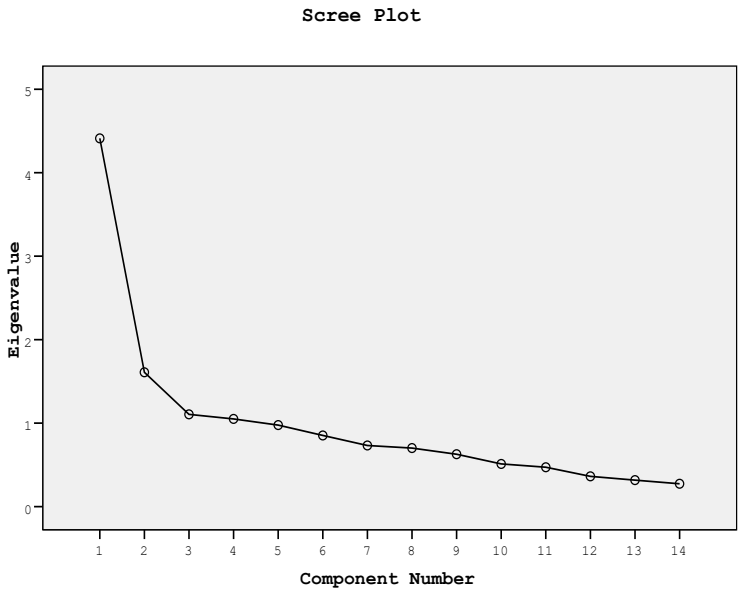


Figure 10. Cattelli diagram for 14 variables

Table 15. *Matrix of factor structure after VARIMAX rotation of factors*

Component Matrix[a]

	Component			
	1	2	3	4
SPRN	,341	,132	,476	,609
PPI	,510	-,450	,275	-,222
KSMN	,538	-,006	,345	-,145
MS	,685	-,219	,292	-,071
SDA	,377	-,411	-,110	,503
DAFZ	,576	-,428	-,275	-,130
RPFC	,785	-,099	,143	-,096
OSODL	,443	-,478	-,221	,090
PST	,721	,091	-,232	-,281
LKO	,388	,487	-,078	-,235
ODK	,492	,401	,326	-,217
IK	,488	,410	,024	,265
OD	,648	,350	-,330	,224
OIZ	,649	,231	-,406	,124

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

The component: during the lesson, the teacher is dedicated and arouses interest among the students; uses modern teaching methods; motivates and involves students in the teaching process, stimulates additional activities in order to increase and expand knowledge of the subject; realizes the planned fund of classes; applies modern technology in the implementation of teaching (computers, software support, information bases, etc.); open and available for consultation and cooperation with students; the exam/ colloquium questions are within the scope of the subject program and the provided basic literature; the content and structure of the exams/colloquium questions enable objective assessment; the grade is a reflection of the students' knowledge and achievement, they refer to the first factor of influence on the teaching process. This factor refers to the quality of teaching and assessment.

The teacher component provides adequate basic and additional literature, the personal culture and attitude of the teacher are at an appropriate level, refer to the second factor of influence on the teaching process. This factor refers to the attitude towards students.The component, the teacher is adequately prepared for teaching, refers to the third factor of influence on the teaching process. This factor refers to the quality of the teacher. The component, the teacher stimulates additional activity for the students (making homework, projects, term papers) refers to the fourth factor of influence on the teaching process. This factor refers to the improvement of the teaching process.

Discussions

The statistical model offered in this paper, which can be practiced very easily, enables continuous monitoring and a basis for corrective actions in order to provide an opportunity on the way to a higher quality teaching-educational process and thus a higher quality higher education. The meaning of the offered statistical model refers to the following:

- A clear picture of the course and realization of the continuous assessment in the academic years is obtained, thereby identifying the weaknesses and realizing the possibilities for their removal by taking corrective actions with the aim of increasing the quality of the teaching-educational process.
- Consultations and communication with students becomes easier based on accurate information at every moment.
- It represents the basis for planning the educational process, that is, the performance of lectures and exercises.

In future research, we will consider Hierarchical Linear Models (HLM) as an advanced statistical technique designed to analyze student achievement data that have internal nested structure, such as students nested within classrooms, institutions of higher education, or districts.

Unlike traditional regression models, which assume independence of observations, HLM explicitly takes this hierarchical arrangement of data into account, allowing for the simultaneous assessment of the effects of individual-level factors (e.g., prior achievement) and group-level variables (e.g., teacher quality or institutional resources) on student outcomes.

This methodological approach is essential to address violations of the independence assumption inherent in standard regression analysis because it models the non-independence of observations within groups, thereby providing more accurate and valid inferences regarding the determinants of student achievement.

Conclusions

The realization and improvement of the quality of higher education, and especially of the teaching-educational process, is a continuous need, obligation and task of every higher education institution and every teacher actively involved in that process. In that sense, the continuous record, the creation of databases that relate to the realization of that process, the processing and analysis of that data with the application of statistical methods and techniques and with appropriate software support is not only a necessity but an imperative.

The proposed statistical model is significant because it can serve as a basis for developing higher education enrollment policies and is designed to be flexible, applicable, and efficient for use at both individual and institutional levels. Its benefits extend to students, faculty, and the entire educational institution.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Institutional Review Board Statement

Not applicable.

Author Contributions

Conceptualization: S.S., R.D. and G.D.; methodology: S.S. and Č.V.; software: Č.V. and Z.G.; formal analysis: S.S. and R.D.; writing—original draft preparation: S.S, R.D. and G.D.; writing—review and editing: Č.V. and Z.G. All authors have read and agreed to the published version of the manuscript.

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Predictors of Attitudes Towards Domestic Violence: The Role of Gender Beliefs and Authenticity

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Abstract: Gender-based violence represents one of the most serious forms of violation of women's human rights, deeply rooted in gender stereotypes and patriarchal patterns. The aim of this study was to examine the relationships between gender beliefs, authenticity in romantic relationships, and attitudes towards domestic violence against women. The research was conducted on a sample of 201 participants through an online platform. The variables were operationalized using the Domestic Violence Myth Acceptance Scale, the Gender Equality Attitudes Scale and the Serbian adaptation of the Authenticity in Relationships Scale – AIRS-22. The results indicate strong and consistent gender differences: on average, men express greater tolerance towards violence compared to women, while women show stronger support for egalitarian gender roles across all domains. The most stable predictor of attitudes towards the justification of partner violence was egalitarianism in the educational role, pointing to the importance of the educational system as a key space for socialization and value transmission. Furthermore, participants from rural areas displayed greater tolerance towards violence and more traditional attitudes about gender roles compared to participants from urban areas. Contrary to expectations, authenticity in romantic relationships did not make a significant contribution in predicting attitudes towards violence, suggesting that global attitudes are predominantly shaped by cultural and social norms rather than individual characteristics. These findings have important implications for the development of preventive and educational programs that emphasize the strengthening of egalitarian values in educational contexts and society as a whole, with particular attention to differences between urban and rural settings.

Keywords: *gender-based violence, justification of violence, gender roles, authenticity, romantic relationships.*

Introduction

Gender-based violence is among the most widespread forms of violation of women's human rights. Its roots lie in historical discrimination, customs, and traditional power structures, where male dominance obtains institutional and cultural legitimacy (Perrin et al., 2022; Watts and Zimmerman, 2022). According to the Istanbul Convention, gender-based violence is that which is directed against a woman because she is a woman or disproportionately affects women, and it encompasses a wide spectrum of phenomena: from domestic violence, sexual harassment, forced marriages, to violations of human rights in armed conflict settings (Council of Europe, 2011; European Commission, 2024). Especially concerning is the presence of violent practices in everyday life, as well as their new face in the digital sphere, where the internet and social networks become arenas for novel forms of control, surveillance, and harassment of women(Wattson, 2021).

According to the UN (CEDAW, 1992), any act of violence based on sex that leads to physical, psychological, or sexual suffering of a woman, including threats of such acts, is a violation of her fundamental rights. Gender-based violence does not remain confined to the private sphere, it also includes institutional neglect, human trafficking, and structural violence manifested through unequal access to resources and decision making (Krug et al., 2002). Violence against women is a serious social and public health issue in Serbia. According to Interior Ministry data, in 2023 some 28,413 domestic violence cases were registered, with victims in over 70 %

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of cases being women (Autonomous Women's Center, 2023). Femicide presents a tragic dimension: between 2011 and 2023, 406 women and girls were killed in family-partner settings (Autonomous Women's Center, 2023).

Gender beliefs, as well as the ways partner relationships are constructed and maintained, play a central role in understanding and justifying domestic violence, particularly when aimed at women (Santoniccolo et al., 2023). Modern societies, despite formal equality, continue to reproduce patriarchal patterns through institutions, media, and interpersonal relations. Santoniccolo et al. (2023) argue that media representations perpetuate stereotypes, objectification, and sexualization, reinforcing belief in patriarchal gender roles and tolerance toward gender injustice. In that context, socially accepted norms and roles may become a basis for tolerating or even justifying violence. Historically, women's subordination was often justified by appeal to biological differences, attributing women the exclusive role of mother and homemaker, while men retained social power and mobility. These roles are not merely socially imposed but deeply embedded in personal and partner relations, contributing to the normalization of violence as a means of control (Indora, 2022).

For these reasons, understanding and deconstructing gender stereotypes, as well as promoting authenticity and equality in partner relationships, are essential steps in violence prevention and in building a society in which all individuals have equal opportunity for a life of dignity without fear. Accordingly, this paper aims to investigate how gender beliefs and the experience of authenticity in partner relationships affect the tendency to justify domestic violence against women.

Gender roles and partner relationships

Gender roles are a multidimensional concept and may refer to a wide spectrum of characteristics, from attitudes and behaviors related to gender roles to personality traits associated with gender (Hentschel et al., 2019). According to the *Dictionary of Gender Equality*, a gender role is "a set of community expectations related to the behavior of individuals in relation to their sex. These are implicit, unquestioned rules that we adopt through upbringing in the family, at all levels of education, through media, cultural content, and within scientific research" (Jarić and Radović, 2010).

Attitudes toward gender roles, ranging from traditional to egalitarian, significantly influence the dynamics of family relationships (Marks and Dollahite, 2009). Traditionalism implies a clear division of roles: the man as provider and authority figure, the woman as caregiver and homemaker (Kokorić et al., 2013; Radcliffe, 2023). In contrast, egalitarian models emphasize equality in decision-making, financial responsibility, and childcare (Knight and Brinton, 2017).Differences in gender roles can be observed in various social contexts: access to education, political power, economic resources, and social representation (Zlatanović, 2022). Women are often assigned less prestigious jobs, face limited access to resources, and in the family setting, responsibilities and obligations are distributed unequally (Marks and Dollahite, 2009). Such distribution not only affects satisfaction within the family but may also contribute to the normalization of inequality and tolerance of violence (Knight and Brinton, 2017).

Partner relationships unfold within a context of deeply ingrained gender expectations. Although the concept of partnership is increasingly free from institutional restrictions, traditional roles still influence how individuals perceive and shape their relationships. According to Antović (2016), intimate partner relationships require adaptation, emotional exchange, and conflict resolution skills. However, when partnership is based on rigid gender roles, conflicts may arise regarding the distribution of power, expectations, and responsibilities (Amato, 2010). Traditional views of male dominance and female submissiveness may reduce women's sense of authenticity and autonomy, thereby increasing the risk of tolerating violence (Yodanis, 2004).

In practice, gender inequality is often institutionalized and manifests itself through various social, economic, and political mechanisms. Legal frameworks, such as the CEDAW Convention (CEDAW Committee, 1992) and the Gender Equality Act (Republic of Serbia, 2009), define discrimination as any act that undermines or interferes with women's enjoyment of fundamental rights on the basis of sex. Nevertheless, legal measures are often insufficient if deeply rooted cultural patterns and gender stereotypes remain unchanged (Inglehart and Norris, 2003).

Gender-based violence

Gender-based violence represents the most drastic manifestation of gender inequality. It encompasses different forms of violenc: physical, psychological, sexual, and economic directed against individu-

als because of their sex, gender, or sexual orientation (United Nations General Assembly, 1993; Council of Europe, 2011). Women and girls are most often victims of such violence, which is a direct consequence of their subordinate position in patriarchal society (WHO, 2013; Watts and Zimmerman, 2002). A specific form is intimate partner violence, characterized not only by cohabitation but also by the intimate relationship between the perpetrator and the victim. In addition to physical and sexual forms, psychological and economic violence also have profound consequences, although they are often less visible. Such forms of violence may include financial control, isolation, threats, manipulation, and denial of basic resources (EIGE, 2022). Violence rarely exists in isolation; multiple forms often overlap simultaneously, which further complicates recognition and intervention (WHO, 2013).

Intimate partner violence often occurs within a pattern that has its internal logic and predictability. It is most often described through the so-called "Cycle of Abuse," which includes three phases: the phase of tension building, the phase of violence escalation, and the phase of remorse and reconciliation (Ignjatović, 2011). This cycle contributes to the victim's continuous entrapment in a violent relationship, as hope for change arises after each violent incident, accompanied by apologies and short-term stabilization.

Typologies of perpetrators of intimate partner violence indicate that violent behavior is not homogeneous. Three dominant types are distinguished: the self-controlled, the impulsive-cyclical, and the instrumental-antisocial (Despotović, 2017; Kelly and Johnson, 2008). The first type is emotionally inhibited and dependent on the partner, the second type is characterized by instability, jealousy, and emotional outbursts, while the third, most dangerous type, uses violence as a conscious means of domination and control, often beyond the family context. Partner violence can also be classified by type: physical, sexual, psychological, economic, and increasingly present stalking. Physical and sexual violence are the most visible forms, but psychological and economic ones have equally destructive consequences, particularly for the victim's self-esteem, emotional stability, and economic independence (WHO, 2013). Economic violence is often the reason why victims remain in violent relationships — due to financial dependence on the perpetrator (EIGE, 2022). Johnson's typology (2008) distinguishes intimate terrorism (violence aimed at controlling the entire relationship), situational couple violence (reactive, episodic), and separation-instigated violence, which is particularly dangerous during the phase of emotional destabilization of the partner. Intimate terrorism is most often associated with male perpetrators and represents the most dangerous and persistent form, often with elements of femicide as the most extreme manifestation of gender-based violence (Johnson, 2008).

The roots of gender-based violence lie in structural inequality and male dominance in most spheres of society. Gender roles, as social constructions, define what is considered "acceptable" for women and men, thus shaping perceptions of violence (Popadić, 2011). For violence to occur, three preconditions must be present: power, authority, and trust, components often inherent in intimate relationships (Popadić, 2011). Research shows that traditional gender roles, which support male dominance and female subordination, increase the risk of violence and the willingness to justify it. In contrast, egalitarian gender ideologies, which promote equality and reject stereotypes, are associated with lower levels of tolerance toward violence (Popadić, 2011). Gender roles affect not only the division of domestic and parental roles but also the perception of fairness and satisfaction within partnerships.

In this sense, deconstructing traditional gender roles and promoting authenticity and equality in partner relationships represent essential steps in preventing violence against women and in building a more just society.

Authenticity as a Protective Factor in Partner Relationships

The quality of intimate relationships is strongly influenced by mutual trust, emotional closeness, and equality. Research shows that high-quality relationships contribute to both partners' psychological and physical well-being (Kiecolt-Glaser and Wilson, 2017). According to social exchange theory, relationship stability stems from perceived benefits and mutual dependence (Cropanzano et al., 2016).

Authenticity, defined by Rogers (1961) as congruence between one's self and experience, is central to healthy relationships. Kernis and Goldman (2006) describe authenticity as a dynamic process involving self-awareness, openness, and behavior aligned with personal values. Authentic individuals are better equipped to express needs, set boundaries, and maintain emotional stability (Rogers, 1961; Seligman, 2002).

Rigid internalization of traditional gender roles can suppress authenticity, increasing vulnerability to control and manipulation (Deci and Ryan, 2000; Kernis and Goldman, 2006). Humanistic and social-psychological perspectives emphasize that authenticity evolves through social interaction and is vital in resisting external pressures (Lazarus, 1991; Tajfel and Turner, 1979). Within intimate relationships, authenticity fosters mutual understanding and protects against gender-based inequality and violence (Brown, 2010; Gottman and Silver, 1999).

By encouraging self-expression over conformity, authenticity strengthens resilience to gender stereotypes and promotes relationships based on respect and equality. In this way, it can serve as a protective factor against destructive dynamics and support the development of healthier partnerships (Perel, 2006).

Understanding the interplay between authenticity, gender beliefs, and attitudes toward violence provides valuable insight into the socio-psychological mechanisms that sustain gender-based violence. This framework connects individual psychological processes with broader social norms, highlighting key points for intervention through education, psychosocial support, and cultural change.

Materials and Methods

The subject of this study concerns the examination of the relationship between gender roles, beliefs about intimate relationships, and attitudes toward violence against women. The primary objective of the research is to investigate the relationship between gender beliefs, authenticity in intimate relationships, and the tendency to justify family or gender-based violence against women. Special emphasis is placed on the role of gender-role beliefs in different domains of life as predictors of tolerance toward violence, as well as the potential significance of authenticity in intimate relationships as a protective psychological factor.

This study seeks to answer the following research questions:

1. To what extent do respondents in Serbia tend to endorse traditional or egalitarian gender roles, and are there differences among groups defined by socio-demographic variables (gender, rural/urban residence, education, age)?
2. Is there a significant association between gender beliefs (traditional/egalitarian) across different domains, authenticity in intimate relationships, and justification of violence?
3. Can gender-role beliefs predict justification of violence in intimate relationships?
4. Does authenticity in intimate relationships moderate the relationship between gender-role beliefs and justification of violence, that is, does authenticity in partnerships act as a moderator between gender beliefs and justification of violence?

Research Hypotheses

H1: Respondents in Serbia will, on average, be more inclined toward traditional than egalitarian gender roles. Women, younger individuals, those with higher education, and urban residents will hold more egalitarian attitudes compared to men, older individuals, less educated participants, and rural residents. Serbia and the Western Balkans are characterized by long-standing patriarchal patterns that still shape gender roles and expectations (Browne et al., 2017; USAID, 2020). However, there is generational and educational differentiation: younger generations, women, and more highly educated respondents show a stronger tendency toward egalitarian attitudes, which aligns with the findings of Almeida et al. (2023), who note that demographic variables such as age and education significantly explain variability in attitudes toward violence and gender roles. Research in Serbia, particularly in rural contexts, indicates that traditional patterns and gender norms are among the key factors shaping attitudes about intimate relationships (Soković and Ranđelović., 2024).

H2: Traditional gender beliefs will be positively associated with justification of violence in intimate relationships. Egalitarian beliefs will be associated with greater authenticity in partnerships, while higher authenticity will be negatively associated with justification of violence. Traditional gender beliefs rest on an asymmetrical distribution of power in partnerships, which often normalizes control and violence (González and Rodríguez-Planas, 2021). Research in Serbia shows that acceptance of patriarchal patterns is strongly linked to greater risk of justifying and tolerating violence (Djikanović et al., 2010). By contrast, egalitarian beliefs promote equality and facilitate freer expression in partnerships, which enhances

the experience of authenticity in relationships (Almeida et al., 2023).

H3: Gender beliefs significantly predict justification of violence in intimate relationships, with traditional beliefs increasing and egalitarian beliefs decreasing justification. Gender socialization theory emphasizes that beliefs about the "proper" roles of men and women are key factors influencing attitudes toward the acceptability of violence (Gage, 2012). In the Serbian context, where patriarchal culture remains strong, traditional beliefs may facilitate justification of violence as a "disciplinary tool" (Soković and Ranđelović., 2024). Conversely, egalitarian beliefs encourage equality and non-violent conflict resolution, leading to lower justification of violence (Almeida et al., 2023).

H4: Authenticity in intimate relationships moderates the relationship between gender beliefs and justification of violence. The negative effect of traditional beliefs on justification of violence will be weaker among individuals with high authenticity. Authenticity entails the capacity for honest expression and consistency with one's values in intimate relationships. Research indicates that this aspect of relationships is linked to healthier emotional functioning and lower tolerance for aggressive behaviors (Miller et al., 2024). Thus, individuals with traditional beliefs who nevertheless highly value authenticity are more likely to reject justification of violence, as it would contradict their sense of personal integrity. Conversely, low levels of authenticity may amplify the negative impact of traditional beliefs (González and Rodríguez-Planas, 2021).

Variables and Instruments

Attitudes toward violence against women were operationalized using the *Domestic Violence Myth Acceptance Scale* (DMVAS; Peters, 2003). The scale consists of 18 statements measuring the degree of agreement with misconceptions about domestic violence. It includes four dimensions: (a) victim character blame, (b) victim behavior blame, (c) excusing or justifying the perpetrator, and (d) minimizing the severity of violence. Respondents answer on a 7-point Likert scale, with higher total scores indicating greater tolerance and justification of violence.

Gender-role beliefs were measured using the *Gender Role Attitudes Scale* (Raboteć-Šarić, 2002). This instrument is an adaptation of the *Sex-Role Egalitarianism Scale* (SRES; Rollero and De Piccoli, 2020) and was constructed to assess beliefs about gender equality across different spheres of social life. Respondents indicate their level of agreement with items on a 5-point Likert scale (from 1 = "strongly disagree" to 5 = "strongly agree"). The scale comprises five subscales: Parental role: equality in childcare, upbringing, and household responsibilities; Social-interpersonal-heterosexual role: gender expectations in social and intimate relationships, including partnership dynamics and interpersonal interaction; Professional role: beliefs about gender equality in employment and careers; Marital/partnership role: attitudes toward decision-making, financial responsibilities, and organization of family life; Educational role: beliefs about gender equality in education, including access, choice of studies, and career orientation. Scores on each subscale range from 16 to 80, with higher scores reflecting more egalitarian attitudes and lower scores reflecting more traditional attitudes.

Beliefs about intimate relationships were operationalized using the Serbian adaptation of the *Authenticity in Relationships Scale* (AIRS-22; Grljak, 2018), based on the original version developed by Lopez and Rice (2006). The scale includes 22 items across two subscales: *Unacceptance of Deception* and *Intimate Risk-Taking*, and has demonstrated satisfactory psychometric properties in the Serbian context. Items are rated on a 9-point Likert scale, with higher scores indicating greater authenticity. *Unacceptance of Deception* refers to authenticity through honesty, measuring the extent to which a person rejects lying or concealment in a relationship. *Intimate Risk-Taking* measures willingness to embrace psychological vulnerability and trust, including sharing deep thoughts and feelings even at the risk of misunderstanding or rejection.

Socio-demographic variables were collected through a short questionnaire, including gender (male/female), place of residence (urban/rural), age (in years) and education level (secondary school, college, university, master's degree, doctoral studies).

Sample and Research Procedure

The sample was convenient and consisted of 201 respondents, of whom 122 (60.7%) were female and 79 (39.3%) male. Participants' ages ranged from 21 to 67 years, with a mean age of 37.8 years (SD = 10.10). Regarding residence, 149 participants (74.1%) were from urban areas and 52 (25.9%) from rural

areas. With respect to education, 58 participants (28.9%) completed secondary school, 27 (13.4%) higher vocational education, 59 (29.4%) university, 53 (26.4%) master's, and 4 (2%) doctoral studies.

The research was conducted online via *Google Forms* in December 2024, and the link was distributed through social media platforms.

Results

In this section, descriptive measures of the main research variables are first presented, followed by the results of the correlation analysis, the relationship between the main variables and socio-demographic variables through *t*-tests and Pearson correlation coefficients, and finally, the results of the hierarchical regression analysis.

Table 1. *Descriptive statistics of the main research variables*

Variables	*Min*	*Max*	*M*	*SD*	*Sk*	*Ku*	A
Attitudes toward violence against women	23	126	68,66	23,22	0,28	-0,51	,89
Interpersonal relations	1,38	5,00	3,97	0,76	-0,66	-0,19	,73
Educational role	1,57	5,00	4,14	0,83	-0,90	-0,05	,76
Professional role	1,44	5,00	4,32	0,73	-1,17	0,81	,82
Partner role	1,20	5,00	4,11	0,76	-0,98	0,77	,81
Parental role	2,15	5,00	4,21	0,73	-0,96	0,10	,85
Rejection of deception	12	108	75,38	-1,51	0,99	0,78	,86
Risk-taking	15	90	75,51	-1,36	1,45	0,52	,87

Note: Min – minimum; Max – maximum; M – mean; SD – standard deviation; Sk – skewness; Ku – kurtosis; α – Cronbach's alpha (internal consistency reliability)

The data in Table 1 show that all variables are normally distributed, as skewness and kurtosis values fall within the ±1.5 range, which some authors suggest as a criterion of normality (Tabachnick and Fidell, 2013, as cited in Dinić, 2019). This satisfies the assumption of normality for applying parametric techniques, which were thus used in further analysis (Fajgelj, 2013).

Regarding attitudes toward partner violence, the average score (M = 68.66, SD = 23.22) indicates a medium level of acceptance/rejection of violence, with relatively high variability among respondents. Skewness (0.28) and kurtosis (-0.51) indicate an approximately normal distribution. Scale reliability was high (α = .89).

All domains of gender roles (interpersonal, educational, professional, partner, parental) had means above 4 on a five-point scale, indicating a tendency toward egalitarian attitudes. The highest egalitarianism was found in the professional role (M = 4.32; α = .82), and the lowest in interpersonal-heterosocial relations (M = 3.97; α = .73), though in all domains responses leaned toward egalitarian values. All subscales demonstrated good to very good internal reliability (α = .73–.85).

Regarding the rejection of deception in partner relations, the high mean score (M = 75.38) indicates that participants largely reject deception as a relational strategy. The distribution was skewed toward higher values, and reliability was high (α = .86). The intimacy risk-taking subscale also showed a high mean score (M = 75.51), indicating openness and honesty in relationships even at the risk of emotional hurt. The distribution was skewed toward higher values (Sk = –1.36), with high reliability (α = .87).

Further, in order to examine the relationships between the main research variables and socio-demographic variables (gender and place of residence), *t*-tests were first conducted, followed by Pearson correlation coefficients.

Table 2. *Gender differences in attitudes toward family violence, gender roles and authenticity in relationships*

Variable	*Gender*	*N*	*M*	*t*	*p*
Attitudes toward family violence	M	79	79.23	5.56	.000***
	F	122	61.83		
Interpersonal relations	M	79	3.44	-8.54	.000***
	F	122	4.31		
Educational role	M	79	3.56	-8.80	.000***
	F	122	4.53		
Professional role	M	79	3.81	-8.57	.000***
	F	122	4.66		
Partner role	M	79	3.50	-10.45	.000***
	F	122	4.51		
Parental role	M	79	3.81	-6.27	.000***
	F	122	4.47		
Rejection of deception	M	79	65.84	-5.09	.000***
	F	122	81.57		
Intimacy risk-taking	M	79	73.00	-1.89	.060
	F	122	77.15		

Note*: M = Men; F = Women; ***p < .001*

The results presented in Table 2 indicate significant gender differences in almost all examined variables. When it comes to attitudes toward family violence, men on average reported significantly higher acceptance of violence (M = 79.23) compared to women (M = 61.83), $t = 5.56$, $p < .001$. Women expressed more egalitarian gender role attitudes across all domains: interpersonal, educational, professional, partner, and parental, with statistically significant differences for each domain ($p < .001$). Regarding authenticity in partner relations, women scored significantly higher on the dimension of rejection of deception (M = 81.57) compared to men ($p < .001$). On the intimacy risk-taking dimension, women also scored slightly higher, but the difference was not statistically significant ($p > .05$).

Table 3. *Differences in attitudes toward family violence, gender roles and authenticity in relationships by place of residence (urban/rural)*

Variable	Place of residence	N	M	t	*p*
Attitudes toward family violence	Urban	149	63.63	-5.467	.000***
	Rural	52	83.10		
Interpersonal relations	Urban	149	4.14	5.588	.000***
	Rural	52	3.48		
Educational role	Urban	149	4.37	6.549	.000***
	Rural	52	3.50		
Professional role	Urban	149	4.49	4.792	.000***
	Rural	52	3.87		
Partner role	Urban	149	4.28	5.434	.000***
	Rural	52	3.63		
Parental role	Urban	149	4.39	5.351	.000***
	Rural	52	3.71		
Rejection of deception	Urban	149	80.85	5.609	.000***
	Rural	52	59.73		
Intimacy risk-taking	Urban	149	75.70	0.294	.769
	Rural	52	74.78		

Note: ***p < .001

The findings presented in Table 3 indicate statistically significant differences between urban and rural participants in most of the examined variables. Respondents from rural areas showed significantly higher acceptance of family violence compared to those from urban areas ($p < .001$). Conversely, participants from urban areas reported significantly more egalitarian attitudes toward gender roles across all domains — interpersonal, educational, professional, partner, and parental ($p < .001$).On the dimension of rejection of deception within partner authenticity, urban respondents scored significantly higher than rural respondents ($p < .001$). On the intimacy risk-taking dimension, however, no significant difference was found ($p = .769$).

Table 4. *Correlations of attitudes toward family violence, gender roles and authenticity in relationships with age and educational status*

Variable	Age	Educational status
Attitudes toward violence	–.022	–.187**
Interpersonal relations	.067	.136
Educational role	.083	.139*
Professional role	. 048	.038
Partner role	.108	.136
Parental role	.049	.116
Rejection of deception	–.028	.139*
Intimacy risk-taking	–.039	–.190**

Note: $p < .05$*, **$p < .01$

As shown in Table 4, age was not significantly related to most of the variables, suggesting that participants' age is not a relevant factor in shaping attitudes toward gender roles, authenticity in partner relationships, or attitudes toward domestic violence.

Educational status, on the other hand, showed moderate positive correlations: individuals with higher education valued egalitarianism more strongly in interpersonal relations (r = .136), educational role (r = .139), parental role (r = .116), as well as in the dimension of rejection of deception (r = .139). At the same time, higher education was associated with lower scores on the intimacy risk-taking scale (r = –.190**).

Table 5. Correlations between attitudes toward violence, gender role dimensions, and authenticity

Variable	Attitudes toward violence
Interpersonal relations	–.538**
Educational role	–.611**
Professional role	–.418**
Partner role	–.548**
Parental role	–.493**
Rejection of deception	–.572**
Intimacy risk-taking	.120

Note: * p < .05, ** p < .01, *** p < .001

The results in Table 5 show that attitudes toward violence were strongly and negatively correlated with egalitarian beliefs across all gender role domains (interpersonal, educational, professional, partner, parental), as well as with rejection of deception. All these correlations were statistically significant at $p < .01$. This means that greater acceptance of violence is associated with lower valuation of egalitarian gender roles and greater tolerance for deception in partner relationships.

On the other hand, attitudes toward violence were not significantly correlated with intimacy risk-taking (r = .12, ns).

Table 6. *Multiple regression analysis for predictors of Attitudes toward family violence, Based on Socio-Demographic Characteristics, Gender Role Beliefs, and Authenticity in Partner Relationships (n = 201)*

Predictors	Model 1 β	Model 2 β	Model 3 β	*Model 4 β*
Age	.056	.045	.042	.034
Educational status	–.136*	–.117*	–.113*	–.113*
Gender (0 = female; 1 = male)	.245**	–.040	–.037	–.045
Place of residence (0 = urban; 1 = rural)	–.272**	–.113	–.107	–.107
Interpersonal role	—	–.142	–.150	–.172
Educational role	—	–.448***	–.415***	–.367**
Professional role	—	.139	.158	.132
Partner role	—	–.117	–.118	–.144
Parental role	—	–.042	–.040	–.021
Authenticity (total score)	—	—	–.074	–.050
Interactions (roles × authenticity)	—	—	—	–.019 to .181
R^2	.22	.42	.42	.44
F	13.53***	15.20***	13.81***	9.61***

Note: $p < .05$, *$p < .01$, **$p < .001$

Hierarchical multiple regression was conducted to examine predictors of attitudes toward family violence- In the first step (Model 1), among socio-demographic variables, significant predictors were educational status (β = –.136, $p < .05$), gender (β = .245, $p < .01$), and place of residence (β = –.272, $p < .001$). Higher educational status, female gender, and urban residence were associated with less tolerant attitudes toward violence. Age did not show a significant effect.

In the second step (Model 2), gender role beliefs were added, which significantly increased explained variance. The strongest predictor was egalitarian beliefs in the educational role domain (β = –.448, $p < .001$). Attitudes in other role domains (interpersonal, professional, partner, parental) were not significant. In this model, the effect of gender was no longer significant, while educational status remained a marginal predictor (β = –.117, $p < .05$).

In the third step (Model 3), the overall authenticity scale was introduced, but its contribution was not significant (β = –.074, ns). The effect of egalitarian educational role beliefs remained strong and stable (β = –.415, $p < .001$).

In the final step (Model 4), interactions between authenticity and each subscale of egalitarian gender roles were included, but none were significant. Egalitarianism in the educational role domain remained the only consistent and strong predictor (β = –.367, $p < .01$), while educational status was marginally significant (β = –.113, $p = .050$).

Valuing equality in educational opportunities was the most important factor associated with rejection of family violence, even when controlling for demographic characteristics and authenticity in partner relationships. Studies on gender roles and intimate relationships (e.g., García-Díaz et al., 2020; Dinić, 2019) indicate that rigid gender norms predict higher tolerance of violence. Given that authenticity entails balance and open communication, a negative association with traditional gender roles can therefore be expected. Authenticity, although theoretically relevant, did not emerge as a significant predictor nor as a moderator between gender roles and attitudes toward violence.

Discussions

The findings of this study indicate that the justification of intimate partner violence is at a medium level, with high variability among participants. This result points to the existence of significant individual differences in tolerance toward violence, which is consistent with previous studies showing that acceptance of domestic violence myths varies depending on sociodemographic factors, cultural contexts, and gender beliefs (Peters, 2008, Gracia and Tomás, 2014). The medium level of tolerance observed in our

sample may be interpreted as a reflection of the ambivalent social context in Serbia, where traditional patriarchal patterns intersect with contemporary values of gender equality (Blagojević, 2013).

Gender differences emerged as one of the most consistent findings: men reported higher levels of violence acceptance and more traditional gender role beliefs, while women expressed stronger support for egalitarianism. These results can be explained through social role theory (Eagly, 1987), according to which men and women are socialized into different value systems. Women, who have historically been more frequently exposed to discrimination and violence, develop greater sensitivity to gender inequality and lower tolerance for violence (Flood and Pease, 2009). Similar results have been obtained in European research, where men systematically show a greater tendency to justify violence and endorse domestic violence myths (Gracia and Herrero, 2006).

In this study, women scored higher across all domains of gender role egalitarianism, which is in line with the findings of Raboteg-Šarić (2002) and Vinagre González et al. (2023), who reported that women internalize expectations involving support for equality in both family and public life. This result may also be related to the fact that egalitarian gender ideologies provide women with a direct protective effect against violence and discrimination (Waltermaurer, 2012).

Differences between urban and rural respondents revealed that participants from rural areas displayed higher tolerance toward violence and more traditional attitudes toward gender roles. This finding is consistent with research suggesting that more traditional cultural contexts, as often found in rural areas, support patriarchal norms legitimizing male dominance and control (Inglehart and Norris, 2003; Kandiyoti, 1988). In contrast, urban participants, exposed to modernization processes and global values of equality, expressed more egalitarian attitudes and lower tolerance toward violence, which aligns with findings from other post-socialist countries (Krizsán and Popa, 2014).

Although authenticity in intimate relationships was highly valued in the sample, the results show that it was not significantly associated with attitudes toward justifying violence. This is noteworthy, as theoretical models suggest that authenticity, understood as consistency with oneself and honesty in relationships (Lopez and Rice, 2006; Kernis and Goldman, 2006), contributes to health and stability in intimate partnerships. A possible explanation lies in the fact that attitudes toward violence have a strong social-normative dimension, and are therefore primarily determined by cultural values and educational context rather than intrapsychic factors (Ajzen, 1991). In other words, authenticity may be more relevant for the quality of specific intimate relationships, but not necessarily for general attitudes toward violence.

Educational status emerged as a relevant factor: higher levels of education were associated with greater egalitarianism across all domains of gender roles and lower acceptance of violence. These findings align with studies showing that education acts as a protective factor by fostering critical thinking and adoption of equality values (Waltermaurer, 2012; World Health Organization, 2021). Age, however, was not significantly related to the variables under study, suggesting that generational differences are not decisive, and that education and sociocultural context play a more dominant role (Gracia and Herrero, 2006).

Strong negative correlations between acceptance of violence and egalitarian gender roles confirm theoretical assumptions that patriarchal gender ideologies are key factors sustaining tolerance for violence (Heise, 1998; Flood and Pease, 2009). Similarly, the association between lower rejection of deception and higher acceptance of violence suggests that individuals who tolerate manipulation and inauthenticity in relationships may be more prone to relativizing violence. On the other hand, the dimension of intimate risk-taking was not significantly related to attitudes toward violence, which may indicate that this aspect of authenticity is more linked to individual intimacy style than to value systems.

Hierarchical regression analysis provided deeper insights into the factors shaping attitudes toward domestic violence. In the first model, among sociodemographic variables, significant predictors were educational status, gender, and place of residence. Higher educational status, female gender, and urban residence were associated with lower levels of violence tolerance. These findings are consistent with previous studies indicating that education plays a protective role against violence tolerance by promoting critical thinking and egalitarian values (Waltermaurer, 2012; Flood, 2015). Furthermore, research consistently shows that men justify violence more often than women (Flood and Pease, 2009; Gracia and Herrero, 2006), while urban contexts, due to greater exposure to modernization processes and global equality values, foster lower tolerance for violence compared to rural settings (Inglehart and Norris, 2003).

When beliefs about gender roles were added in the second model, the explained variance significantly increased, with educational role egalitarianism emerging as the strongest predictor of lower

violence acceptance. This result confirms that not all domains of egalitarian beliefs are equally relevant, but that the educational context represents a key space for internalizing values that counteract violence justification. From a social constructionist perspective (Berger and Luckmann, 1966), education is not only an institution for knowledge transmission but also a mechanism through which social norms are formed. It is therefore understandable that educational egalitarianism, as an indicator of a broader belief system of equality, has the strongest predictive significance.

The introduction of authenticity in the third step did not show a significant contribution, indicating that individual intrapsychic characteristics do not play a decisive role in shaping general attitudes toward violence. This can be interpreted within the framework of the Theory of Planned Behavior (Ajzen, 1991), according to which attitudes are more strongly shaped by social norms and contextual expectations than by personal traits. Although authenticity is relevant for the quality of specific intimate relationships (Kernis and Goldman, 2006; Lopez and Rice, 2006), its influence on global attitudes toward violence appears to be mediated by cultural factors.

In the final model, introducing interactions between authenticity and gender egalitarianism subscales did not yield significant effects, suggesting that authenticity does not moderate the relationship between gender roles and attitudes toward violence. In this model, educational role egalitarianism remained the only stable and strong predictor, while educational status was at the threshold of statistical significance. This suggests that education has a dual role: it directly influences attitudes toward violence, but even more strongly through shaping egalitarian beliefs in the educational domain.

Conclusions

The findings indicate that support for gender equality in the educational domain is the strongest predictor of attitudes toward domestic violence, underscoring the educational system's crucial role in violence prevention. Promoting egalitarian values through formal education and targeted programs can significantly reduce tolerance for violence.

Attitudes toward domestic violence are not merely individual but reflect broader cultural and social structures. Gender and urban-rural differences were evident, with women and urban participants showing higher rejection of violence and stronger egalitarian beliefs. Although authenticity in intimate relationships is theoretically relevant, it did not emerge as a significant predictor in this study, suggesting that educational and cultural factors play a more prominent role.

These results highlight the importance of integrating gender-sensitive education policies and tailored interventions, especially in rural areas where patriarchal norms remain influential. However, the study has limitations: a convenience sample, gender and urban bias, and reliance on self-reported measures may affect the generalizability of findings. Future research should use more representative samples, combine methods, and explore how educational and cultural contexts influence attitudes toward violence. Such efforts can support the development of effective, evidence-based prevention strategies.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Institutional Review Board Statement

Not applicable.

Formal approval from an ethics committee was not required for this study. However, all participants were fully informed about the nature and purpose of the research and provided their voluntary, anonymous, and informed consent in accordance with the principles of the Declaration of Helsinki.

Author Contributions

Olivera Radović: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft. Zvezdan Arsić: Investigation, Formal Analysis, Writing – Review & Editing, Visualization. Dragana Stanojević: Methodology, Formal Analysis, Writing – Review & Editing. All authors have read and approved the final version of the manuscript.

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Dialogism of Generation Y and Generation Z in Online Communication

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Abstract: The article presents the results of research in comparing ability for dialogical communication of representatives of two generations: Y and Z of two orientations (collectivistic and individualistic). The personality traits which are the basis of dialogism in online communication are specified, the model of dialogism of online communication is presented and measured in order to highlight the difference of ability to build dialogical communication among representatives of generation Y and Z online. Dialogism in online communication is understood as a construct with core and periphery. We used the questionnaire of individualism and collectivism indicators (L.G. Pochebut), "System of Life Meanings" technique (SLM) (V.Y. Kotlyakov), multi-factor empathy questionnaire (V. V. Boyko), "Tolerance Index" questionnaire (G.U. Soldatova and other), "Social norms of prosocial behavior" (I.A. Furmanov), Freiburg Multifactor Questionnaire (Farenberg, Zarg, Gampel). When comparing the results of representatives from generation Y and generation Z the significant difference was stated between most factors. It was concluded that core of dialogism of two generations is different: Z representatives of collectivistic orientation and Y representatives of individualistic orientation have such elements as: aggressiveness, neurotic traits, depressiveness, irritation, emotional instability. The core of dialogism of millennials of collectivistic orientation and Z individualistic orientation is represented by tolerance, some kinds of prosocial behaviour and sociability. Both generations and orientations have altruistic and communicative meanings in the core. The periphery of dialogism of all groups is represented by empathy and some kinds of prosocial behavior.

Keywords: *generations Z and Y, personality traits, empathy, tolerance, openness, empathy, prosocial behavior, value-meaning orientation.*

Introduction

Due to digitalization of recent two decades and active development of online communication, interest of the scientists to the quality of online communication was raised. As the internet communication develops, young people experience lack of face-to-face communication and educating institutions need to take actions to improve interpersonal communication skills (Moisei, 2024). Measuring indicators of dialogism in online communication has potential for better understanding the difference of online behavior of representatives of both generations and can be implemented in development of courses for raising dialogistic communication quality.

Millennials and generation Z differ dramatically from the point of view of behavior as well as intrinsic values (Karakuttikaran and Kolachina, 2024)

The impact of globalization and digitalization on millennials was already noticed by Howe and Strauss, 2000 (Reeves, 2007) and since the level of internet influence on young people has been increasing, the younger generation, so called media natives, are completely formed and defined by technology (Singh and Dangmei, 2016). Their inner world, including values, meanings, personal traits and ways of reacting to reality differ from previous generation which is reflected in online communication (Twenge, 2006). Decrease of dialogism in modern communication due to digitalization was criticized by Linell (Lourenço, Basto, Cunha, and Bento, 2013).

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The concept of dialogism as exchange of facts in speech and exchange of meanings was firstly introduced by M. Bakhtin and developed by a number of philosophers, linguists and psychologists. H. Hermans developed the idea of dialogism into Dialogical Self Theory (DST) (Hermans, 2001) where he makes emphasis on socially constructed identity. In the dialogue identity emerges from inter-voice dynamics, and voices are shaped by social discourses (e.g., gender norms, ideologies). So personal identity and discourse are interconnected and mutually influenced. The necessity of dialogism for therapy in the field of psychology has also been proved. To change one's identity, one has to be in constant dialogue with himself, challenging dominant self-narratives by innovations which emerge through dialogical ruptures (Hermans and Thorsten, 2014). The loss of dialogical self-organization and disintegration of self-dialogue can be conditioned by personality destruction in cases of mental disorders like schizophrenia (Lysaker and Lysaker, 2010). Dialogical personality in terms of psychotherapy processes was studied a lot (Dimaggio et al. 2010) and (Stiles, 2011).

In attempts to analyze which traits of personality contribute to dialogism in communication we revealed openness (McCrae and Sutin, 2018), empathy (Decety and Cowell, 2014; Deutsch, 2006), tolerance, emotional stability (Gross, 2015), collectivistic value meaning system (Sanchez-Burks et al.2003).

Such traits like aggressiveness (Hopwood and Wright, 2012), absence of altruistic and communicative meanings and excessive self-focus like in case of narcissism (Campbell and Foster, 2007) on the contrary act as dialogism prevention factors.

We suppose that dialogism can be presented as a construct with empathy, tolerance, value meaning orientation, communicative and altruistic meanings and such personal trait as openness, emotional stability, emotional balance and prosocial behavior. Some elements can be positioned in the core and the others – in the periphery. On the contrary, low indicators on openness, empathy, tolerance, altruistic and communicative meanings, aggressiveness, irritability, depressiveness, neuroticism, emotional liability can prevent dialogism (we call it adialogism).

A great number of researches have been conducted to study personal traits of dialogism of generations Y and Z. The values (Karakuttikaran and Kolachina, 2024, Deutsch, M. 2011, Črešnar and Nedelko, 2020), nature, level and quality of empathy (Lamm, 2023; Cherry, 2020; Decety and Cowell, 2014; Kritti, 2024), tolerance (McBeth, 2022); Tulgan, 2013; Twenge et al, 2019) differ from generation to generation.

It has already been noted that generation Z in comparison with Y is more inclined to diversity. Millennials have been developing tolerance (equality in marriage etc.), generation Z have a more diverse approach to more social phenomena like gender fluidity, intersectionality; diversity means more racial and ethnical diverse, it correlates with higher acceptance of multiculturalism and interracial relationships (Parker and Igielnik, 2020). What makes generation Z more diverse than generation Y? First of all, Z are internet natives, they think broadly, have no geographical limits and on the other hand they have lower level of critical thinking in comparison with generation Y due to digital overload, short formats of information (tik-tok), decreasing dynamics on reading books and long articles (Twenge et al, 2019). As a result of digitalization algorithm-driven content discourages deep reading and fact-checking, generation Z tends to prioritize speed over accuracy in information consumption (Baron, 2021) and are vulnerable for misinformation (Seemiller and Grace, 2016). Another basis for criticism of generation Z actions is their constant fight over internet (boycotts, posts, petitions, twitter mobs) instead of systemic view and problem-solving approach, taking into account dual nature of the social processes and the world in general. The dichotomy reasoning brings young generation to vulnerability, depression, aggression (Lukianoff and Haidt, 2018) Z's choice to solve conflicts on social media field contributes to building victimhood culture, where young people compete for the title of the most oppressed group. Together with moral dependency (appealing to authorities on most conflicts, like HR, administrators) and micro aggression complaints, when any minor misconduct perceived as systemic harm generation Z can be assumed as most victimized generation (Lukianoff and Haidt, 2018). Such attitude does not contribute into ability to build strong relationship on transparent and clear communication, prevents young people from dialogism.

Collectivistic value meaning orientation when discussing Millennials has been emphasized by the tendency to group collaboration (Howe and Strauss, 2000) in comparison with Z generation, where collaboration is needed for entertainment mostly (Gabrielova and Buchko, 2021).

In order to study deeper the difference of dialogism of both generations we measured the mentioned above personal psychological traits, specified the level of dialogism of four groups and compared discourses of respondents to realize if dialogism is expressed in discourse accordingly.

Materials and Methods

A total of 784 respondents voluntarily participated in the study, 413 representatives of generation Y (born between 1981 and 1999) and 371 representatives of generation Z (born between 2000 and 2010), male and female. The geography of the study includes Moscow, Novosibirsk, St. Petersburg, Blagoveshchensk, and Rostov-on-Don. The study consists of the following stages: study of value meaning orientation of representatives of both groups (collectivistic or individualistic orientation) by means of the questionnaire of individualism and collectivism indicators (Pochebut, 2012). As a result, we formed four groups (Y with individualistic orientation, Y with collectivistic orientation, Z with individualistic orientation and Z with collectivistic orientation). We used "System of Life Meanings" (SLM) technique (Kotlyakov, 2003) to measure life meanings of four groups, multi-factor empathy questionnaire (Boyko, 1994) to measure the level and quality of empathy, "Tolerance Index" questionnaire (Soldatova et al., 2008.) to measure level and quality of tolerance, "Social norms of prosocial behavior" (Triandis (1995)) to study which kinds of prosocial behaviour all four groups tend to choose, Freiburg Multifactor Questionnaire FPI (Form B) (Kukhtova, and Domoratskaya, 2011) to measure such personality traits like openness, aggression, shyness, emotional stability or liability. At last, we applied content analysis to the discourses of representatives of four groups in order to reveal if the level of dialogism of the group (measuring personality traits) coincide with the number of dialogistic codes in discourse.

Here comes the description of methods.

L.G. Pochebut "Indicators of individualism - collectivism" technique (Pochebut, 2012) is based on the identification of the cultural syndromes of Triandis (1995): collectivism and individualism. The questionnaire consists of 30 statements, each of them marks one of the poles of the continuum of collectivism-individualism.

The methodology of studying the system of life meanings by V.Y. Kotlyakov (Kotlyakov, 2003) is used to determine life meanings. The questionnaire consists of 24 statements that should be ranked. Then, for each meaning (altruistic, existential, hedonistic, self-realization, status, communicative, family, cognitive) rank values are calculated, and the lowest rank value has the greatest importance in the system of human life meanings.

The method of diagnosing the level of empathic abilities by V. V. Boyko (Boyko, 1994) is a questionnaire of 36 statements that divide the answers into 6 scales:

- rational channel of empathy, focus of attention, perception and thinking of another personы feelings;
- emotional channel of empathy, the ability to be with the object of empathy "on the same wavelength", the ability to "feel into the situation of another", emotional alinement to the empathized;
- intuitive channel of empathy determines the ability to act in a situation of lack of information about another and on the basis of experience accumulated in the subconscious;
- attitudes promoting empathy, which characterize the presence/absence of attitudes that contribute to a high/low level of empathy.
- identification in empathy reflects the ease, flexibility, mobility of an individual's emotions, easy adjustment and the ability to put oneself in another's place, the ability to imitate.
- pervasive ability in empathy is assessed as a communicative property of an individual, necessary for creating an atmosphere of openness, trust, which directly contribute to empathy, and vice versa, low scores on this scale mean that a person does not know how to create an atmosphere of openness and trust;

The main result is a point score, and an auxiliary result can be obtained by interpreting the results for each scale separately.

To measure tolerance, the express questionnaire "Tolerance Index" (Soldatova et al., 2008) was used. This questionnaire consists of 22 statements that must be assessed from "absolutely disagree" to "completely agree". The questionnaire includes three subscales: ethnic tolerance, social tolerance and tolerance as a personality trait. Social tolerance demonstrates the attitude towards some social minorities (mentally ill, poor), ethnic tolerance demonstrates the attitude towards representatives of other ethnic groups, races. The subscale "tolerance as a personality trait" demonstrates beliefs (respect for opinions different from one's own, readiness for dialogue and conflict resolution). In addition to high, medium or low levels of tolerance, different subscales can be considered to assess not only the level, but also the qualitative characteristics of tolerance.

To measure prosociality (prosocial behaviour) the method "Social norms of prosocial behavior" (Kukhtova, 2021) was used. This method is presented by 62 statements that determine a person's beliefs about helping others and are reflected in 4 subscales:

- the norm of social responsibility is the belief that "people should help each other", following these beliefs is necessary to avoid feelings of guilt and maintain stability of self-esteem, this norm requires that a person helps in any case when another person depends on him, which is due to a sense of responsibility and causal attribution;
- the norm of reciprocity is set of beliefs about "exchange relations", that is, a person's belief that he/she will be helped if he helps;
- the norm of justice is set of beliefs that benefits should be distributed in accordance with efforts, with costs. "Everything should be fair", including helping each other;
- the "cost-reward" norm reflects a person's beliefs about helping others in emergency situations, in situations that cause distress.

The Freiburg Personality Questionnaire FPI is designed to diagnose states and personality traits that are of high importance for the regulation of behavior and communication. The FPI questionnaire contains 12 scales; Form B differs from the full form only by a smaller number of questions. The total number of questions in the questionnaire was 114. We were interested in sociability, emotional stability, openness, aggressiveness, neuroticism.

The content analysis was applied according to methodology of Kimberly Neuendorf for quantity analysis and Klaus Krippendorff for quality conceptual analysis.

The data were statistically processed using the Shapiro-Wilk test, median values, Kruskal-Wallis criterion, K-means, PCA (Principal Component Analysis), content analysis of written discourses. We made assumptions: H1- personal psychological traits which are responsible for dialogism in communication like empathy, tolerance, openness, collectivistic value-meaning orientation, altruistic and communicative meanings, emotional stability, sociability, and prosocial behavior differ between representatives of two generations qualitatively and quantitatively. H2 - high level of dialogistic traits of personality is reflected in discourse.

Results

The Shapiro-Wilk test confirmed that the sample of data (784 results) does not belong to a normally distributed population. As a result, we chose median values, which were analyzed for four groups (Y collectivists -25%, Y individualists -28%, Z collectivists -23%, Z individualists -24%). Here we mention only the outstanding results. Generation Z (collectivists and individualists) show higher results in rational, emotional and intuitive empathy channels (M=4) in comparison with generation Y (M=2). They have also high results in identification of empathy and Z individualists show higher results in pervasive empathy.

Tolerance index shows the highest scores of generation Y. Social tolerance is higher (M=38), comparing with other groups (M=33), tolerance as a personality trait is higher (M=37) in comparison with three other groups (M=32). The general level of tolerance: Y collectivists (M=107), Y individualists (M=104,5), Z collectivists (M=97) and Z individualists (M=92). Life meaning system questionnaire showed high scores in communicative values for Z individualists (M=13), the lowest score for Y individualists (M=7), for altruistic values Z collectivists (M=13) and Z individualists (M=12) compared to Y collectivists (M=11) and Y individualists (M=8).

FPI showed the highest scores for neuroticism, openness, irritability, emotional liability and aggressiveness of Z collectivists. The other groups did not show any specific difference.

In norms of prosocial behaviour (M=7) according to the scale of reciprocity norm (exchange relations) Y collectivists ranked higher in comparison with other groups (M=6, 3-6,5). Z collectivists demonstrated the highest scores on social responsibility (M=12, 5), only half point higher than three other groups.

The next stage was aimed at finding out to what extent all four groups are different according to the measured traits and how significant this difference is. We applied Kruskal-Wallis criterion (Table 1).

Table 1. *H-criterion. Difference significance of personal psychological traits*

Personality psychological traits	H-criterion / significance		Comparison inside Y generation (collectivists (C)-individualists (I))	Comparison of Y and Z generations inside of collectivistic value-meaning orientation	Comparison of Y and Z generations inside of individualistic value-meaning orientation	Comparison inside Z generation (collectivists (C)-individualists (I))
			Y, C- Y, I	Y, C- Z, C	Y, I- Z, I	Z, I- Z, C
Rational channel of empathy	131,391	P<0,001	p 0,007 (C<I)	p<0,001 (Z>Y)	p<0,001 (Z>Y)	
Emotional channel of empathy	31,012	P<0,001		p<0,001 (Z>Y)		p<0,001 (I<C)
Intuitive channel of empathy	36,119	P<0,001	p 0,003 (C<I)	p<0,001 (Z>Y)		p 0,003 (I<C)
Attitudes that promote empathy	53,131	p 0,024		p<0,001 (Z>Y)	p <0,001 (Z>Y)	
Pervasive ability in empathy	9,401	P<0,001	p 0,012 (I<C)		p 0,002 (Y<Z)	
Identification in empathy	120,108	P<0,001		p<0,001 (Z>I)	p <0,001 (Z>I)	
Norm of social responsibility	29,628	P<0,001		p<0,001 (Z>Y)		p <0,001 (C>I)
Norm of reciprocity	141,157	P<0,001	p 0,027и (C<I)	p<0,001 (Z>Y)	p<0,001 (Z>Y)	
Norm of justice	36,95	P<0,001	p<0,001 (C>I)	p<0,001 (K>I)		
Norm of cost-reward	28,572	P<0,001		p<0,001 (K>I)		
Altruistic meanings	30,539	P<0,001		p<0,001 (Z>Y)	p<0,001 (Z>Y)	
Level of tolerance	100,872	P<0,001		p<0,001 (Y>Z)	p<0,001 (Y>Z)	
Ethnic tolerance	141,337	P<0,001		p<0,001 (Y>Z)	p<0,001 (Y>Z)	
Social tolerance	49,717	P<0,001	p 0,033 (C>I)	p<0,001 (Y>Z)	p<0,001 (Y>Z)	
Tolerance as a personality trait	17,692	P<0,001		p<0,001 (Y>Z)	p<0,001 (Y>Z)	
Neuroticism	281,655	P<0,001	p<0,001 (C<I)	p<0,001 (Z>Y)	p<0,001 (Z>Y)	p <0,001 (C>I)
Spontaneous aggressiveness	210,195	P<0,001		p<0,001 (Z>Y)	p<0,001 (Z>Y)	
Depressiveness	150,127	P<0,001		p<0,001 (Z>Y)	p<0,001 (Z>Y)	
Irritability	143,29	P<0,001	p<0,001	p<0,001 (Z>Y)	p<0,001 (Z>Y)	
Sociability	69,57	P<0,001	p 0,01 (C>I)	p<0,001 (Y>Z)	p<0,001 (Y>Z)	
Balance	63,378	P<0,001	p 0,002 (C<I)	p<0,001 (Y>Z)	p<0,001 (Y>Z)	
Reactive aggressiveness	41,696	P<0,001	p 0,003 (I>C)	p<0,001 (Z>Y)	p<0,001 (Z>Y)	
Openness	196,111	P<0,001		p<0,001 (Z>Y)	p<0,001 (Z>Y)	
Emotional lability	296,655	P<0,001		p<0,001 (Z>Y)	p<0,001 (Z>Y)	p 0 ,002 (C>I)

As follows out of the table all scales of tolerance, empathy, prosocial behavior, life meanings and personal traits have significant difference inside generations and inside value-meaning orientation.

At the next stage we applied cluster analysis to identify personality psychological traits grouped naturally. We received two clusters and here comes the description. When assessing the percentage of respondents who fell into clusters, it was found that:

The first cluster mostly consists of Generation Y (it included 73.5% individualists and 85.1% collectivists)

The second cluster, on the contrary, mostly consists of Generation Z (67.0% individualists and 79.9% collectivists). The first cluster was dominated by: all tolerance indicators: general, ethnic, social, tolerance as a personality trait, cost-reward norm (prosocial behavior); sociability; balance (emotional stability). The second cluster was dominated by: altruistic and communicative life meanings, rational and emotional channels of empathy, general empathy; reciprocity norm (prosocial behavior); neuroticism; spontaneous aggressiveness; depressiveness; irritability; emotional lability; openness.

So, at this stage we can accept H1. The results show significant difference in dialogism quality: for generation Y (first cluster) all tolerance indicators are typical: general, ethnic, social, tolerance as a personality trait, cost-reward norm (prosocial behavior); sociability; balance (emotional stability). Dialogism of generation Z is based on empathy, reciprocity, norms of prosocial behavior and openness, but

has indicators of adialogism like neuroticism; spontaneous aggressiveness; depressiveness; irritability; emotional lability.

It is important to notice that generation Y cluster includes no personal psychological traits which prevent dialogism (like aggressiveness, depressiveness, irritability, emotional liability), which proves that this generation is more dialogic. It is also worth to signify that altruistic and communicative life meanings were only specified in Z generation cluster. Factors in both clusters are represented in Table 2.

Table 2. *Factors represented in 2 clusters*

Factors	1 cluster	2 cluster
Rational channel of empathy	-0.3928104	0.4147306
Emotional channel of empathy	-0.3193282	0.3371479
Intuitive Empathy Channel	-0.263947	0.2786762
Attitudes that promote empathy	-0.1657499	0.1749993
Penetrating power in empathy	0.0700873	-0.0739984
Identification in empathy	-0.2743749	0.289686
General empathy	-0.4239101	0.4475658
Social responsibility	0.0528368	-0.0557852
Norm of reciprocity	-0.4188191	0.4421907
Norm of justice	0.1556937	-0.1643819
Cost-reward	0.354938	-0.3747448
Altruistic meanings	-0.3611787	0.3813338
Communicative meanings	-0.2811196	0.2968071
Ethnic tolerance	0.4711973	-0.4974918
Social tolerance	0.35265	-0.3723291
Tolerance as a personality trait	0.2656954	-0.2805222
General tolerance	0.484459	-0.5114936
Neuroticism	-0.6236496	0.6584515
Spontaneous aggressiveness	-0.6164374	0,6508368
Depressiveness	-0.6063147	0.6401492
Irritability	-0.6253794	0.6602778
Sociability	0.2724351	-0.287638
Emotional balance	0,2066082	-0.2181377
Reactive aggression	-0.3586997	0.3787165
Openness	-0.4772753	0.5039089
Emotional lability	-0.5993781	0.6328255

In order to identify elements of core and periphery of dialogism and in order to understand the role of value-meaning orientation we applied PCA (Principal Component Analysis) for each generation group.

Generation Z showed a lower dispersion of the first two components (lower completeness of the sample description by the obtained components – 17 and 15.3%, respectively), that is reflected in table 3.

Table 3. *Generation Z, distribution of 2 components*

Factor	1 component	2 component
Rational channel of empathy	0,07643	0,08404
Emotional channel of empathy	0.05133	0,00411
Intuitive Empathy Channel	0.02923	0,01723
Attitudes that promote empathy	0.02228	0.06185
Penetrating power in empathy	0.15294	0.02403
Identification in empathy	0.04012	0.02768
General empathy	0.00016	0.11732
Social responsibility standard	0.05694	0,00064
Norm of reciprocity	0.38705	0.00409
Norm of justice	0,05650	0,00080
Standard of remuneration expenditure	0.21151	0.02816
Altruistic meanings	0.00934	0.47849
Communicative meanings	0,00117	0,68120
Ethnic tolerance	0.30635	0.00375
Social tolerance	0,18166	0.00294
Tolerance as a personality trait	0.29650	0.00585
General tolerance	0.50015	0,00788
Neuroticism	0.35553	0,01585
Spontaneous aggressiveness	0.62032	0.00688
Depressiveness	0.42251	0.00096
Irritability	0.62769	0,00000
Sociability	0,08848	0,00483
Emotional balance	0.00023	0.00532
Reactive aggression	0.38074	0.00556
Openness	0.20387	0,00678
Emotional lability	0.43728	0,00008

Generation Y has higher dispersion rates of the first two components (20.5 and 12.1%, respectively), that is reflected in table 4.

Table 4. *Generation Y, distribution of 2 components*

Factor	1 component	2 components
Rational channel of empathy	0,07643	0,08404
Emotional channel of empathy	0.05133	0,00411
Intuitive Empathy Channel	0.02923	0,01723
Attitudes that promote empathy	0.02228	0.06185
Penetrating power in empathy	0.15294	0.02403
Identification in empathy	0.04012	0.02768
General empathy	0.00016	0.11732
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Openness	0.20387	0,00678
Emotional lability	0.43728	0,00008

For each generation correlation circles were compiled. When constructing a correlation circle (the correlation between the indicator of the feature fed into the model and the selected component is estimated), the following results were obtained: for Y individualists high correlation – the core of dialogism (0,4-0,6) was revealed for neuroticism, irritability, depressiveness, spontaneous aggressiveness, openness; for Y collectivists -general tolerance, social tolerance, ethnic tolerance, sociability; for Z individualists – cost reward norm, social , ethnic tolerance, tolerance as trait of character, sociability; for Z collectivists – irritability, spontaneous aggressiveness, reactive aggressiveness, norm of reciprocity, emotional liability, neuroticism, depressiveness. For all four groups communicative and altruistic meanings have high correlation (0,6), which means each group has these meanings in the core of dialogism. Empathy (all kinds) and some kinds of prosocial behavior have lover correlation index (0,2), which means these features will be placed at periphery.

Now we proceed to H-2. We analyzed 559 written discourses of four groups of respondents. The task was to write how respondents understand dialogue in on-line communication, participants of dialogue, what is the purpose of dialogue.

At the first stage we specified two themes: dialogism and adialogism. As a result of qualitative content analysis at the coding stage, the following codes for the theme “dialogism” with different word forms were identified: listening (active, attentive), conversation, mutual, relationships, mutual understanding, mutual respect, ready to hear/listen/hear, trust, critical thinking, bridge, communication, open, relationships, understanding, acceptance, equal, development of relationships, meaning, creating a common understanding, calm, creativity/creation, tolerance, respect, ability to listen, establish the truth, truth. Codes for the theme “adialogism”: interaction, change, express an opinion, discussion, presentation of facts, tool, tool for achieving a goal, exchange of information, exchange of thoughts, exchange of remarks, transfer of knowledge, conversation, solution, problem solving, coordination of actions, dispute, means of communication/exchange, means of achieving a goal, style/manner/method, fun/entertainment, transfer of meaning, convince, establishing contact, simplifying life, establishing connections, goal, pleasure. The “dialogic” group includes words connected in meaning with an empathic attitude, reciprocity, listening, attention and respect for the interlocutor, with acceptance, perception of the interlocutor as an equality, comprehension, consideration, with the depth of relationships and feelings. The adialogic codes are represented by words expressing the attitude to dialogue as an exchange of information, a tool, entertainment, management, expressing a utilitarian meaning. A total of 53 codes (semantic units - words and expressions) were encountered in 559 texts (episodes) 776 times.

The next step was to group the codes into larger groups, for example, words such as mutual understanding, mutual relations, mutual respect, mutual* (word forms of the word mutual) were combined into the code group “reciprocity”. Such words and expressions as active listening, ready to hear, ability to listen were combined into the code group “listening”. Thus, in dialogism, the following code groups(categories)

were distinguished: reciprocity, listening, communication, community and understanding, trust, critical thinking, openness, relationships, equal, calm, creativity/creation, tolerance, respect, truth. In adialogism, the following code groups (categories) were identified: interaction/coordination, influence, conversation, instrument, exchange, transfer, solution, means, style/manner, simplification/entertainment, connection/ contact.

Code categories of dialogism are presented at Figure 1, code categories for adialogism are presented at Figure 2.

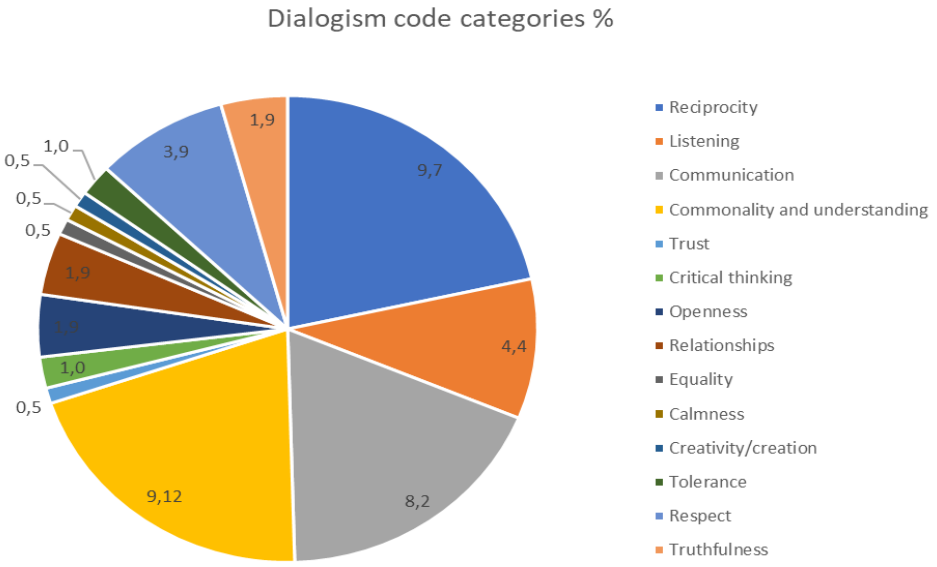

Figure 1. Code categories of dialogism theme

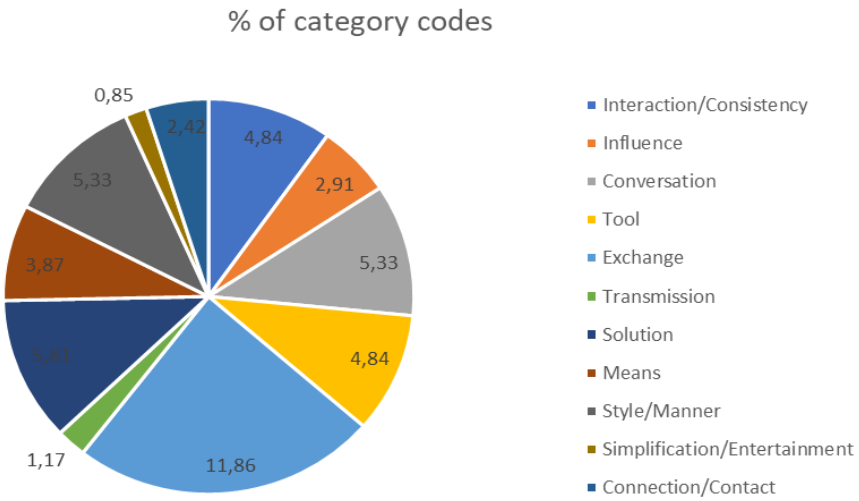

Figure 2. Code categories of adialogism theme

At the last stage we calculated which out of four groups has in their discourses more dialogism codes and which one has more adialogism codes. Figure 3 and 4 show the distribution of dialogism and adialogism categories in discourses of different generation and value-meaning groups.

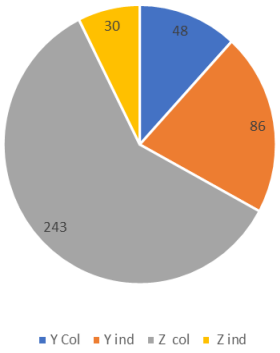

Figure 3. The distribution of dialogism categories in discourses of four groups

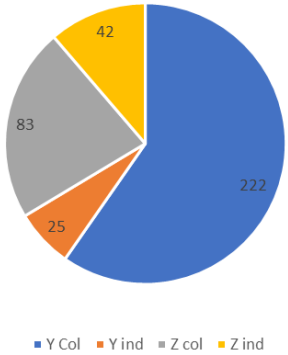

Figure 4. The distribution of adialogism categories in discourses of four groups

Discussions

The obtained results show that representatives of generation Y are more dialogistic in online communication due to the absence of psychological personal traits which prevent dialogism like aggressiveness, neuroticism, depressiveness, shyness and emotional liability. They seem to understand dialogue in online communication as well as they do in off line communication. For them dialogue is the process of mutual listening, understanding, where interlocutors are treated with respect and equality. This can be explained by the fact that generation Y use online communication like extra channel, extra tool to maintain relationships offline. They seem to accept online communication like additive way of communication and apply the same attitude to online dialogue as to offline one. Collectivistic value-meaning system helps them to maintain collaboration, to which they tend online as well as offline, they have enough offline relationships and they do not concentrate on online only. Individualists of generation Y have less tendency to collaboration due to their value-meaning organization, as a result they are more exposed to influence of online communication styles and express adialogism personality psychological traits in online communication. Z generation individualists have approximately the same level of dialogism as Y individualists and have medium expression of dialogism in their discourses. Their value-meaning orientation does not demand a lot collaboration by any means, even though they appreciate communication and have altruistic meanings. The most adialogistic group is representatives of generation Z of collectivistic orientation. We suppose this can be the result of the inner conflict of their need in collaboration and inability to maintain it online. As it is known young generation enter big number of groups and leave them as easily as they entered, under these circumstances it is impossible to maintain collaboration and dialogism cannot be developed due to the presence of adialogism psychological personal traits. They perceive online communication as a tool for utilitarian purposes and do not have enough ability to develop communication offline.

Conclusions

Online communication of representatives of two generations differ due to the value-meaning orientation (individualistic and collectivistic) and belonging to a certain generation group. Other psychological peculiarities like openness, empathy, prosocial behavior, tolerance, altruistic and communicative meanings, emotional stability/lability, neuroticism, aggressiveness, irritability, sociability define the level of dialogism in on-line communication.

The level of dialogism (openness, motivation to communicate (communicative meaning), be in the group (collectivistic orientation), high level of tolerance, empathy and prosocial behavior, sociability and altruistic meanings) is expressed in the online discourse. The basis of dialogistic online communication is introduced by semantic codes connected with trust, tolerance, openness, equality.

Adialogistic online communication is explained by low tolerance and empathy, as well as by the

presence in personality such traits like aggressiveness, irritability, emotional lability, depressiveness, neuroticism and expressed in online discourse by semantic codes with instrumental meaning.

Due to low level of dialogism in personal traits and expression of adialogism in discourse generation Z representatives need to be trained for communication competence, especially those who have collectivistic value -meaning orientation.

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Conflict of interests

The authors declare no conflict of interest.

Data Availability Statement

The derived data and the results of this study are available on request from the corresponding author. The data have been anonymized, but are not publicly available due to privacy issues.

Institutional Review Board Statement

Not applicable.

Participant Consent Statement

All participants involved in this study consciously and voluntarily participated in the research.

Author Contributions

Conceptualization, D.D., and V.P.; methodology, DD., and V.P.; software, D.D.; formal analysis, D.D..; writing—original draft preparation, D.D.; writing—review and editing, D.D., and V.P; validation, D.D., and V.P. All authors have read and agreed to the published version of the manuscript.

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Screening Tool Facilitating Mainstream School Practitioners to Assess Educational Needs of Children With Autism Spectrum Disorders: The Bulgarian Case

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Abstract: Over the years, research has demonstrated that individuals with autistic spectrum disorders are a heterogeneous group. In recent years, the concept of inclusive education has provided additional insight into the possibilities of working with children with ASD in mainstream schools. The purpose of this study is to outline the specific strengths, capacities, and opportunities for supporting children and students with ASD in mainstream schools. The Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY) indicators were used as a basis and applied to different forms of ASD diagnosis, looking for more detailed individual profiles and common resources outlined despite the possible differences by gender, age, diagnoses, and according to specific difficulties and areas where children and students have difficulties. Sample comprised 201 children and students, aged 3-19 years. The results highlight the strengths and resources of a large number of the respondents with ASD, outlining their capacity in communication, language mastery and thinking. From one-fifth to more than half of the respondents do not encounter challenges when the environment and context are supportive. The reported results highlight the implications of the universal tool that teachers and educators have for thorough and in-depth outlining the personal development scope and areas. It can serve as a screening instrument in mainstream setting, alerting mainly teachers, but also families about the measures that address needs of children and students with ASD in view to facilitate personal growth.

Keywords: *children with Autism Spectrum Disorder, inclusive environment, Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY).*

Introduction

The diagnostic profiles of children with autism spectrum disorder (ASD) reveal a spectrum of challenges that underscore the complexity of their educational requirements. Most notably, communication deficits manifest through limited social engagement and difficulties in comprehending verbal cues, necessitating individualised interventions tailored to each child's unique profile (Bagetti et al., 2023). These profiles often highlight a reliance on specific support frameworks, such as those aligned with the International Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY), to ensure effective inclusion in educational settings. The heterogeneity observed in social interactions indicates not only a need for targeted language development programs but also emphasises fostering emotional regulation and cognitive skills, which are critical for academic achievement. Overall, understanding these diagnostic profiles is crucial for developing long-term support strategies to enhance the educational outcomes and social adaptation of children with ASD.

The diagnostic criteria for ASD have evolved significantly, particularly with the publication of the DSM-5, which redefines ASD as a single continuum rather than a collection of distinct categories. This modification aimed to streamline the diagnostic process and reflect the heterogeneous nature of the

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spectra. Current criteria necessitate the presence of symptoms in two critical domains: social communication and restricted, repetitive behaviours, which must manifest in early developmental periods and cause functional impairments in daily life (Durkin, 2019). Recent analyses emphasise the necessity for a multidimensional approach to assessment, considering cognitive, emotional, and social factors indicative of each child's unique profile. Furthermore, the utilisation of frameworks such as the International Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY) has underscored the significance of context in understanding the educational and interpersonal needs of children with ASD, thus advocating for inclusive strategies that consider individual variability.

The heterogeneity in symptomatology and behavioural manifestations among children with Autism Spectrum Disorder (ASD) presents significant challenges for both diagnostic processes and intervention strategies. Individuals on the autism spectrum exhibit a diverse range of communication difficulties, social interaction impairments, and behavioural issues, necessitating a nuanced understanding of their individual needs to effectively tailoring educational strategies. Research indicates that this heterogeneity frequently involves limited social engagement, whereby numerous children avoid peer contact and experience difficulties with group participation, underscoring the need for targeted interventions to foster social skills and inclusion. Furthermore, deficits in cognitive and emotional regulation can impede children's ability to manage daily activities, as they frequently encounter challenges in maintaining attention and coping with frustration. As noted in the literature, employing assessment tools such as the Adaptive Behaviour Assessment System (ABAS-3) can provide a comprehensive framework to evaluate functioning and guide individualised support, ensuring that each child's educational experience is appropriately customised (Shah et al., 2019).

The role of early diagnosis in educational planning for children with ASD is pivotal, as it enables tailored interventions that align with the unique needs of each child. Early identification facilitates the implementation of specific educational strategies that consider not only the diagnostic criteria but also the broader biopsychosocial context, as emphasised in the International Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY) (Mahdi et al., 2018; Vallefuoco et al., 2022). Research has demonstrated that children experience significant challenges in communication and social interactions, often necessitating individualised educational frameworks that promote engagement. Furthermore, effective educational planning incorporates insights into environmental factors, as these contexts significantly influence children's participation and functionality in educational settings. The emphasis on early diagnosis underscores the importance of a proactive approach that enables educators and caregivers to foster holistic development and support inclusion, thereby addressing both immediate and long-term educational needs.

Multidisciplinary assessments are crucial in developing comprehensive diagnostic profiles for children with Autism Spectrum Disorders (ASD), as they provide a holistic view of an individual's strengths and challenges. By incorporating insights from various professionals, such as clinicians, educational specialists, and therapists, these assessments lead to tailored interventions that address the diverse needs of autistic children (Mahdi et al., 2018; Balsa, 2023). For instance, the analysis of functional profiles utilising the ICF-CY highlights significant variations in social and communicative capabilities among children, revealing that many experience difficulties in initiating social contact and participating in group activities. Additionally, the findings emphasise the necessity of individualised support, as children often require long-term assistance in language development and emotional regulation. This multidisciplinary approach not only enhances documentation and evaluation processes but also aligns interventions more closely with the real-world complexities faced by children with ASD, facilitating their long-term inclusion and support. Accurate diagnosis of ASD is fraught with challenges, significantly compromising the efficacy of long-term support and inclusion strategies, as outlined by the ICF-CY framework. The diagnostic variability can result from overlapping symptoms with other developmental disorders and a lack of standardised assessment tools, which complicates the determination of individuals' functional abilities. Further complicating matters are the acknowledged heterogeneity among children with ASD, where individual differences in communication, social skills, and cognitive functioning necessitate personalised diagnostic approaches (Hayden-Evans et al., 2022). Additionally, environmental factors, ranging from familial support to school contexts, play a crucial role in shaping the developmental trajectories of these children, underscoring the necessity for a framework that considers these variables. Moreover, the need for long-term interventions that address specific challenges in communication and emotional regulation emphasises the critical nature of accurate initial diagnoses to effectively tailor educational support.

Autism Spectrum Disorders (ASD) encompass a range of neurodevelopmental conditions characterised by impairments in communication, social interaction, and repetitive behaviours. The heterogeneity of ASD manifests variably across individuals, influencing their daily functioning and quality of life. This complexity is reflected in the increasing prevalence of ASD diagnoses and the subsequent increase in the educational support requirements of the affected children. Research indicates that children with ASD typically experience challenges in communication, attention, and social skills, necessitating tailored interventions. Moreover, factors such as social engagement, emotional regulation, and cognitive flexibility play critical roles in their development, underscoring the necessity for an inclusive educational framework that accommodates these diverse needs. Utilising the International Classification of Functioning, Disability and Health (ICF-CY) framework allows for a comprehensive understanding of how environmental and personal factors interact with the core characteristics of ASD, ultimately guiding effective support strategies (Viljoen, 2019; Krieger, 2022).

Understanding the intricacies of diagnostic profiles is essential for effectively meeting the educational requirements of children with ASD, as these profiles encompass each child's distinct challenges and abilities. Thorough evaluations reveal considerable variation in social and communicative skills, directly shaping individualised educational approaches. This underscores the need for bespoke interventions to bolster various aspects of communication, emotional management, and social integration. Employing frameworks such as ICF-CY provides a more profound understanding of how children's impairments interact with their daily activities, stressing the importance of continuous support across various contexts. This comprehension forms the foundation for effective long-term strategies to improve academic and social outcomes, ensuring that children with ASD flourish in inclusive settings (Okoye et al., 2023; Narciso et al., 2024). Furthermore, as noted in, acknowledging in symptom presentation can inform the creation of targeted interventions, further emphasising the importance of personalised support tailored to specific diagnostic profiles.

The educational needs of children with ASD are highly complex, influenced by a multitude of factors, including individual capabilities, environmental influences, and social contexts. Evidence suggests that interventions tailored to the unique profiles of these children can significantly enhance their learning experiences and overall functionality. Critical areas of focus include language development, social skills, and emotional regulation, as children frequently experience difficulties in communication and social interactions. Furthermore, the International Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY) emphasises that contextual elements play a crucial role in shaping educational outcomes (Viljoen, 2019). Differences in functional abilities are frequently observed across gender lines, necessitating gender-sensitive approaches to educational strategies (Buxbaum , 2021). Bystrova et al. (2017) confirmed that children with ASD have specific features of visual perception irrespective the level of intelligence and perceive graphic images differently, is important for the school educational environment

Addressing these diverse needs through individualised education plans can facilitate both inclusion and long-term support for children with ASD within educational settings (Erasmus, 2018; Hasson et al., 2022).

The traditional deficit-based model of autism has increasingly been challenged by the neurodiversity paradigm, which conceptualizes autism as a natural variation in human cognition and emphasizes the need to support autistic strengths within inclusive environments (Pellicano and den Houting, 2022). The authors advocate for greater emphasis on contextual factors—such as sensory-friendly settings and inclusive educational practices—rather than narrowly targeting individual deficits. They also highlight the importance of participatory research approaches, exemplified by Australia's Autism CRC, which aligned research agendas with community-defined priorities and invested in lifespan-oriented supports co-developed with autistic individuals.

Autism's heterogeneity has also received growing attention. For example, the shift to a single ASD diagnosis in DSM-5 has been critiqued for obscuring meaningful subgroups. A dimensional approach—considering variables such as language ability, intellectual level, gender, and comorbidities—can better capture individual differences and guide tailored and individualized interventions (Lai et al., 2013).

Recent neuroimaging studies further support autism's complexity. Using resting-state functional MRI and regularized canonical correlation analysis (rCCA), researchers identified three key brain–behavior dimensions—verbal IQ, social affect, and restricted and repetitive behaviors (RRB)—and four reproducible autism subtypes with distinct neural and gene expression profiles: (1) high verbal IQ with elevated RRB; (2) low verbal IQ with elevated RRB; (3) high social-affect symptoms with low RRB; and (4) low social-affect symptoms with high RRB. Transcriptomic analyses showed that each subtype was associ-

ated with unique gene expression patterns, pointing to molecularly and neurofunctionally distinct forms of autism (Buch et al., 2023). These findings underscore the neurobiological heterogeneity of ASD and challenge its conceptualization as a uniform condition, highlighting the value of dimensional and subtype-specific approaches in research and intervention.

Recent research has placed greater emphasis on learning environments and inclusive education, highlighting the critical role of educational context and individualized support in promoting positive outcomes for autistic students. Lohmann et al. (2023) studied the use of Universal Design for Learning (UDL) in inclusive preschool science classrooms, showing that UDL strategies support diverse learners, including children with ASD, by enhancing engagement and understanding. Their findings provide empirical support for UDL's role in early inclusive education (Lohmann et al., 2023).

Similarly, differentiated instruction - adapting teaching methods, materials, and assessments to students' individual needs - has been shown to significantly improve task completion, academic engagement, and performance for children with ASD (Ameen, 2024). Furthermore, multi-sensory teaching grounded in a neurodiversity perspective supports greater engagement and learning for neurodiverse students with ASD (Sewell, 2022).

In a multicenter study across 10 countries (N = 122), clinicians used the ICF–CY checklist to assess functioning in individuals with ASD, identifying 139 relevant categories across body functions, activities, and environmental factors. The results underscore the heterogeneity of ASD and support the use of the ICF–CY as a comprehensive framework for individualized support and inclusive education planning (Mahdi et al., 2018).

The findings of our study align with the results of an international clinical investigation by Mahdi et al. (2018), which applied the ICF-CY framework to assess functioning in individuals with ASD across diverse cultural contexts. Their study identified a broad range of relevant categories, highlighting significant variability in abilities, support needs, and environmental influences. This reinforces our focus on identifying individual strengths and contextual facilitators in children and students with ASD. Like their findings, our results emphasize that many autistic individuals demonstrate competencies in areas such as communication, cognitive processing, and learning—particularly when supported by inclusive, well-adapted environments.

The focus of the contemporary approach to managing ASD has been directed on a bio-psycho-social framework that considers an individual's abilities and disabilities as a result of the interaction between health, environment and personal factors (WHO, 2001; WHO, 2007) and the creation of the International Classification of Functioning, Disability and Health (ICF). An example of work in this direction is a series of international studies (Mahdi et al., 2018) and studies in other countries involving experts worldwide (Bölte et al., 2014) with the aim of adapting the International Classification of Functioning, Disability and Health (ICF) guidelines for autism spectrum disorders (ASD) and, specifically, functioning in autism (as operationalised by the ICF), drawn from the perspective of diagnosed individuals, family members and professionals.

The provision of long-term support and inclusion for children with ASD is essential for fostering optimal developmental outcomes and enhancing the quality of life for both the child and their family. Comprehensive interventions that extend beyond the initial diagnosis are critical; they assist in addressing not only academic challenges but also the social and emotional deficits that characterise the disorder. Research indicates that children with ASD often require individualised support, including tailored educational strategies and consistent adult supervision, to promote engagement and participation in diverse settings. Moreover, the ICF-CY framework underscores the importance of contextual factors in evaluating the functionality and capabilities of these children, which encompasses their sustainability in educational environments and community life (Damyanov, 2024). Ongoing support not only mitigates behavioural challenges but also facilitates meaningful peer interactions, contributing to the child's overall well-being and social integration.

The ICF-CY provides a comprehensive framework for assessing the diverse needs of children, particularly those diagnosed with ASD. This classification model emphasises the significance of understanding not only disabilities but also the functional capacities and social participation of children, enabling a more holistic approach to intervention and support. The heterogeneity of ASD, highlighted in the ICF-CY framework, reveals substantial variations in social interactions and communication abilities among the affected children, necessitating tailored educational strategies. Furthermore, ICF-CY underscores the critical role of contextual factors in shaping developmental outcomes and emphasises the necessity for individualised support mechanisms (Nugent, 2016; Dale, 2021). Utilisation of this classification system can facilitate enhanced identification of specific educational requirements, thereby assisting educators

and clinicians in fostering inclusive environments that promote meaningful participation for children with ASD. Table 1 describes the main areas of challenges (Damyanov et al., 2023).

Table 1. *ICF-CY Dimensions and Functioning Levels*

Dimension	Functioning Level	Example	Prevalence Rate
Body Function	Functions related to mental and behavioural performance	Cognitive functioning, emotional regulation	Approximately 70% of children with ASD exhibit challenges in this area
Activities	Capabilities to execute tasks or actions	Learning, communication, self-care	Over 40% of children with ASD have significant difficulties
Participation	Involvement in life situations	Engagement in social activities, schooling	Estimated 30% of children with ASD experience barriers
Environmental Factors	External factors influencing functioning	Support from family, educational settings	Positive support can reduce challenges for up to 50% of children

The ICF serves as the basis for assessing and measuring disability. In recent years, research has been conducted to nationally adapt assessment tools according to the World Health Organization's International Classification of Functioning, Disability, and Health (ICF), including its version for children and youth, e.g. in Taiwan (Hwang et al., 2015). In some studies, a differentiation was made, with those trained to implement the Identification Card comprising only teachers; the Functional Diagnosis group only of multidisciplinary health professionals from Disability Services; and the group for the Achievable Functional Goal Profile and Individual Education Action Plan being heterogeneous in composition and comprising both teachers and operators from Disability Services (Mohapatra and Dwivedi, 2024). Some research has pointed towards creating a single disability variable for children with varying degrees of disability, ICD-10 diagnoses, and age using the WHO ICF-CY coding system for bodily functions (Illum and Gradel, 2015). Other ICF-CY-based studies have focused on specific conditions. An example is the functioning of individuals with autism spectrum disorder (ASD) are the research, conducted with representatives from 10 countries (Mahdi et al., 2018) and assessment of adults activity and participation in Taiwan (Liao et al., 2022), the degree of functioning of children and their families in Argentina (Napoli et al., 2021). Studies are also focused on other groups with disabilities, eg. such as cerebral palsy (Schiariti et al., 2014). Studies are also being conducted not only to adapt and validate, but also to monitor the applicability of the International Classification of Functioning, Disability and Health, version for Children and Youth (ICF-CY). An example is social and scholastic inclusion for students with disability in Treviso province, Italy (De Polo et al., 2009).

In this article are reported the results concerning the implementation of ICF-FY by teachers and educators as a part of the teams, ensuring personal development in mainstream inclusive setting.

Understanding the diagnostic profile and educational needs of children with Autism Spectrum Disorders (ASD) necessitates a comprehensive examination of their distinctive characteristics and challenges. The prevalence of ASD has drawn significant attention to the importance of tailored educational strategies that address individual needs, particularly within the framework of the International Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY). This model emphasises the multifaceted nature of autism and elucidates how environmental, social, and personal factors interact to influence educational outcomes. As children with ASD frequently exhibit various impairments in communication, social interactions, and emotional regulation, effective long-term support systems must be designed to foster inclusion and participation. Consequently, this survey aims to analyse the critical role of long-term educational interventions, emphasising the necessity for specialised approaches that promote holistic development and social adaptation of children with ASD in inclusive settings.

Materials and Methods

This research is based on a field study conducted during the implementation of functional assessments of children and students with special educational needs in kindergartens and schools by a team from the Regional Center for Support of the Process of Inclusive Education (RCSPIE) in Sofia City. The assessment process took place between September 2023 and October 2024 and included the assessment of 201 children and students diagnosed with autism spectrum disorder between the ages of 3 and 19. This fieldwork provided substantial empirical data on the diverse educational and developmental needs of children with ASD, further informing discussions about effective intervention strategies in inclusive educational settings.

The functional scorecard based on the Bulgarian Model of Inclusive Education administered in this study is designed for quantitative and qualitative indicators measuring child and adolescent development, allowing for detailed profiling and collection of in-depth information that can be used for individual profiling.

The instrument applied in this study is the Functional Assessment Map of the Individual Needs of Children and Students with Special Educational Needs and Chronic Diseases, officially developed and implemented in Bulgaria in 2023 under the national project "Support for Inclusive Education," funded by the Ministry of Education and Science. The instrument is based on the International Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY) developed by the World Health Organization (WHO, 2007), and adopts its bio-psycho-social model and coding structure.

The construction of the tool involved a multistage expert validation process, including:

- Multidisciplinary expert contributions (special educators, psychologists, speech therapists, occupational therapists, physicians, and social workers);
- External academic review by leading national scholars in the field;
- Pilot testing in partnership with UNICEF Bulgaria, involving specialists from regional support centers.

The instrument is conceptually validated by design through the ICF-CY framework and adapted to the Bulgarian educational context.

With regard to psychometric properties, inter-rater reliability is supported by mandatory national standardized training for all evaluators. The assessment teams operate through interdisciplinary discussions, applying clearly defined scoring guidelines. For preliminary screenings, a binary system is used (e.g., presence or absence of special needs indicators), while for full assessments, the standard ICF-CY ordinal qualifiers (0–4) are applied for each domain.

Training for raters was delivered by master trainers certified by the Ministry of Education and Regional Centers for Support of Inclusive Education. The training includes both theoretical and practical modules, emphasizing consistent application of the rating procedures and ensuring calibration among raters.

In this stage of the study, descriptive and categorical analyses were employed to present preliminary profiles of the assessed population. In future stages of the project, more advanced statistical methods such as regression analysis and multivariate models will be applied to explore deeper relationships between the functional domains, contextual factors, and educational outcomes.

Research aim

The *aim* of the study is to produce initial findings, highlighting the role of teachers and educators in inclusive environment and early screening and intervention, and:

1. provide optimal individualized profiling of strengths and weaknesses in the process of development and interaction with children and students with ASD according to the criteria set out in the functional scorecard;
2. facilitate professionals in the recognition and management of their observations in the process of interaction with children with ASD;
3. outline the common features and abilities, irrespective the specificities of gender, age and type of ASD.

The *research questions* are:

RQ1: What specific common strengths, difficulties and resources can be highlighted and are there clear gender, age and ASD specificities?

RQ2: What improvements can be made in the diagnostic process to track the personal development of children and students with ASD?

RQ3: What conclusions can be drawn to support professionals and mainstream teachers to support the individual potential of each child and student with ASD?

Method

ICF-FY based functional scorecard developed for Bulgaria was administered. There are 7 general indicators, each of which contains sub-indicators), shown in table 2.

Table 2. *Description of the respondents*

	ICF-FY based indicators	Sub-indicators
1.	Language - structure of language, rules	remembers abstract concepts, imitates sounds and phrases, lack of speech, finds the right word, unintelligible speech, grammatically incoherent speech, understands meaning when reading, understands new concepts, uses speech for communicative purposes, merges sounds, composes sentences, sound analysis and synthesis
2	Thinking	organizational skills, putting information into practice, understanding cause and effect relationships
3	Interpersonal Interactions	emotional regulation, initiating and responding appropriately to social interactions, responding to physical contact in a socially acceptable manner, socially acceptable behaviour
4	Attention and perceptions	holds attention briefly, has difficulty sitting still in class, does not listen or respond to instructions, relies on peers and copies their actions
5	Educational outcomes	has difficulty in only some areas, learns on an individual plan, works cooperatively with other children, copes with group tasks
6	Social communication	uses inappropriate voice volume/intonation, makes off-topic comments, maintains conversation, changes topic frequently, laughs at inappropriate times/rude, deliberate use of eye contact
7	Auditory memory	forgets instructions, needs constant guidance

Sample

A total of 201 respondents between the ages of 3 and 19 were surveyed, and assessments were requested by their parents following a request for additional personal development support in all areas of the country. As the focus of the study was on children and students diagnosed with ASD, 37 of the 201 respondents who did not have an accurate diagnosis or who had other behavioural and emotional/ hyperactivity disorders were excluded. Therefore, the total number of participants whose results were analysed was 164. Due to the fact that there are missing responses for some of the indicators, in the results presented, the responses vary and for some indicators are below 164. The most common diagnosis is F.84 ASD (118), the others are F84.8 Other pervasive developmental disorders (31) and less ASD with complications (9), F84.1 Atypical autism (5) and Asperger - only 1 (Table 3).

Table 3. *Description of respondents by sex, age and diagnosis*

Diagnosis	Sex and age	
	Boys	Girls
ASD with complications (N = 9)	N =7: 2: 7 y.o., 3: 9 y.o., 1: 12 y.o. and 1: 13 y.o.	N = 2: 7 and 16 y.o
Asperger (N = 1)	N = 1: 14 y.o.	-
Atypical autism (N = 5)	N = 2: 7 y.o. and 8 y.o.	N = 3: 7, 10 and 11 y.o.
F84.8 Other pervasive developmental disorders (N = 31)	N = 24 1: 3 y.o., 3: 4 y.o., 2: 5 y.o., 1: 6 y.o., 5: 7 y.o., 3: 8 y.o., 5: 9 y.o., 1: 10 y.o., 1: 11 y.o., 1: 13 y.o., and 1: 14 y.o.	N = 7: 1: 4 y.o., 2: 7 y.o., 1: 8 y.o., 1: 10 y.o. and 2: 12 y.o.
ASD (N = 118)	N = 87 1: 3 y.o., 4: 4 y.o., 8: 5 y.o., 3: 6 y.o., 18: 7 y.o., 17: 8 y.o., 14: 9 y.o., 2: 11 y.o., 4: 12 y.o., 6: 13 y.o., 4: 14 y.o., 1: 15 y.o., 2: 16 y.o., 2: 17 y.o., 1: 18 y.o.	N = 31 3: 4 y.o., 3: 5 y.o., 3: 6 y.o., 6: 7 y.o., 4: 8 y.o., 6: 9 y.o., 1: 11 y.o., 1: 12 y.o., 1: 13 y.o., 2: 16 y.o. and 1: 19 y.o.

Results

The results are reported for the seven survey indicators. For each indicator, the significant differences reported by sex, age and diagnosis, are indicated. Data are summarized according to the number and percentage of children and students who have challenges and who have no challenges, respectively, on each indicator and sub-indicator. Language mastery is described by sub-indicators in Table 4.

Table 4. *Scores on speech proficiency, comprehension and use of speech for communicative purposes*

Language - language structure, rules		N	%
Remembers abstract concepts	Yes	66	43
	No	88	57
Imitates sounds and phrases	Yes	140	85
	No	24	15
Lack of speech	Yes	140	86
	No	23	14
Finds the right word	Yes	58	44
	No	75	56
Unintelligible speech	Yes	124	79
	No	33	21
Grammatically incoherent speech	Yes	33	22
	No	119	78
Understands meaning when reading	Yes	26	18
	No	116	82
Understands new concepts	Yes	60	43
	No	80	57
Uses speech for communicative purposes	Yes	100	64
	No	56	26
Merges sounds	Yes	32	21
	No	122	79
Constructs sentences	Yes	32	21
	No	123	79
Sound analysis and synthesis	Yes	66	42
	No	93	58

In respect to overall language mastery and speech development outcomes

- The main challenges are lack of speech (86%), unintelligible speech and difficulty in constructing sentences (79%), understanding the meaning in reading (82%)
- More than half of children and students with ASD have difficulties in remembering abstract concepts, new concepts and finding the right word, but 44% find the right words, 43% understand abstract concepts and new concepts, 42% cope with sound analysis and synthesis.
- Much more than half of the children and students with ASD can imitate sounds and phrases (85%) and have grammatically coherent speech (78%), 64% use speech for communicative purposes, and 79% do not merge sounds
- No gender differences were accounted
- Significant difference was found in respect to the personal support for remembering abstract concepts - 53% of children and students with short-term support, 40% of those with long-term support, and 19% of those without support remember concepts compared with 82% of those without support. 47% with short-term support, and 60% with long-term support do not remember abstract concepts (χ^2 = 6.795, p = .033; Phi and V = .210; p = .033). There was also a significant difference with respect to lack of speech, which relates to 94% of children and students without personal support, 94% of those with long-term support, and 73% of those with short-term support (χ^2 = 14.043, p = .001; Phi and V = .294; p = .001). Unintelligible speech occurred most frequently among children and students without personal support (94%), followed by those with long-term support (86%), and least frequently in those with short-term support (66%) (χ^2 = 11.347, p = .003; Phi and V = .269; p = .003). Reading comprehension was also higher for children and students with short-term support (32%) compared to 7% for those without and 10% for those with long-term support (χ^2 = 11.914, p = .003; Phi and V = .290; p = .003). The place of support emerges particularly for sentence composition, with no child in the group without support can perform with this compared with 28% of children and students with short-term support and 19% of those with long-term support (χ^2 = 6,460, p = .040; Phi and V = .204; p =.040).
- There was a significant difference also by diagnosis - in terms of imitating sounds and phrases, the highest percentage of challenges were observed in the group Other pervasive developmental disorders (94%), followed by ASD (86%), ASD with complications (67%) and atypical autism (60%) (χ^2 = 12.698, p = . 013; Phi and V = .278; p = .013) and in the use of speech for communicative purposes, where the highest rates were for ASD with complications (89%), followed by childhood autism (69%), atypical autism (60%), and other pervasive developmental disorders (41%) (χ^2 = 11,784, p = .019; Phi and V = .275; p =.019).
- Significant differences reported by age were in imitation of sounds and phrases, where most challenges encountered 3-5 y.o., 8 and 9 y.o., 17-19 y.o. Lack of speech was prevailing (100%) for 3-6 y.o., 97% for 7-8 y.o., 100% for 11, 17 and 18 y.o. Prevalence of unintelligible speech, 100%, was among 3-5 y.o., 15 and 17 y.o. and serious challenges for 7 y.o. Coherent speech was reported without challenges for 13 y.o. and 15 y.o. 10 y.o., 11 y.o., and 15 y.o. use speech for communicative purposes (100%). For merging sounds best (100%) performed 4 y.o. and 5 y.o., 11 y.o., 14 y.o., 15 y.o., 17 y.o., and 18 y.o. Sentence composition was worst for 3-5 y.o., and best among 15 y.o., which replicates the typical development.

The results for the mastery of cause-effect relationships, the relationship between information and its practical application, and self-organization are described in Table 5.

Table 5. *Scores for challenges and performance on the indicator Thinking*

Thinking		N	%
Organisational skills	Yes	17	11
	No	139	89
Implementation of information in practice	Yes	56	36
	No	98	64
Understanding causal relationships	Yes	29	19
	No	126	81

In terms of thinking, the overall results outline

- The main challenges reported concern the organisational skills (89%) and understanding causal relations (81%), whereas more than half of the respondents are unable to apply what they have learned in practice.
- It should be noted that slightly over one third (36%) of the children and students surveyed manage to put the information into practice
- As a significant gender difference here, it appeared that more girls (22%) compared to boys (7%) had developed organizational skills ($\chi^2 = 6.999$, $p = .012$; Phi and V = .212; $p = .008$).
- For thinking, no relation was reported with the support provided
- There was a significant relation between diagnosis and organizational skills, which were highest for ASD with complications (44%), followed by atypical autism (25%), and lowest for ASD (9%) and other pervasive developmental disorders (8%) ($\chi^2 = 12{,}267$, $p = .015$; Phi and V = .280; $p = .015$).
- Age: 15 y.o. and 16 y.o. (100%) performed best in applying the information in practice and well performed (50%) 3 y.o., 10 y.o., 11 y.o., and 12 y.o. Causal relations were understoom best by 18 y.o. and 19 y.o. and worst (0%) among 17 y.o., 14 y.o., 15 y.o., 11 y.o., 5 y.o., 6 y.o., and 3 y.o.

The components of interpersonal interactions are outlined in Table 6.

Table 6. *Challenges and resources outlined for interpersonal interactions*

Interpersonal interactions		N	%
Emotional regulation	Yes	25	16
	No	135	84
Initiation and appropriate response to social interactions	Yes	35	22
	No	125	78
Socially acceptable response to physical contact	Yes	52	33
	No	106	67
Socially acceptable behaviour	Yes	38	24
	No	119	76

In respect of interpersonal interactions the summarized results indicate that

- Major challenges are observed in emotional regulation (84%), initiating and adequate involvement in social contact (78%), and socially acceptable behaviour (76%)
- Although more than half of children and students with ASD studied do not respond in a socially acceptable manner to physical contact, it shall be noted that one-third (33%) respond appropriately and one-fifth (24%) demonstrate socially acceptable behaviour
- No gender differences were reported
- Socially acceptable behaviour was found to have a significant relationship with support provided, with best performance of children and students with short-term support (36%), followed by those with long-term support (17%) and no support (14%) ($\chi^2 = 7.165$, $p = .028$; Phi and V = .214; $p = .028$).
- There was a significant relation between diagnosis and initiating and responding appropriately to social interactions; this was reported for 37% of children and students with other pervasive developmental disorders, 22% of those with ASD with complications, 18% of those with ASD, and 0% of those with atypical autism ($\chi^2 = 9.692$, $p = .046$; Phi and V = .246; $p = .046$).
- In respect to age emotional regulation was worst among 3-5 y.o., 11 y.o., 15 y.o., 17-19 y.o. Responding appropriately to physical contact was greatest challenge (0%) for respondents aged 3-5 y., 17-19 y. and was best (100%) for 15-16 years old.

Attention and perception scores are described in Table 7.

Table 7. *Attention and perception challenges and resources*

Attention and perceptions		N	%
Holds attention for a short time	Yes	140	85
	No	24	15
Has difficulty sitting still in class	Yes	140	86
	No	23	14
Does not listen or respond to instructions	Yes	123	79
	No	33	21
Relies on peers and copies their actions	Yes	32	21
	No	122	79

For attention and perceptions, the results reveal that

- The main challenge for the children and students with ASD is to hold attention (85%) and, respectively, to remain sitting still during class (86%), listening and responding to instructions (79%), and lack of mastery of peer behaviour patterns (79%)
- One-fifth of the respondents are able to learn by role models of peers, listen and respond to instructions, and over one-tenth cope to hold their attention for long periods of time
- No gender differences were observed
- There was a significant difference in the support provided - again, the highest percentage of children and students who perceive and respond to instructions was in the group with short-term support (34%), followed by children and students with long-term support (14%) and only 6% in the group without support (χ^2 = 11.145, p = .004; Phi and V = .067; p = .004). Children and students with short-term support were more likely (27%) than those with long-term support and no support to be able to sit still in class (χ^2 = 14,043, p = .001; Phi and V = .294; p =.001).
- Significant differences by diagnosis was accounted in attention retention, with children and students with atypical autism performing best (40%), followed by those with ASD with complications (33%), ASD (14%), and least (7%) for other pervasive developmental disorders (χ^2 = 12.698, p = .013; Phi and V = .278; p = .013).
- Age: Attention retention was most difficult in 3-5, 8-9, 17-19 y.o. 100% unresponsive to instructions are 3-5 y.o., 15 and 17 y.o. Imitation of peers was best (100%) for 10 and 19 y.o. and worst (0%) among r 4, 5, 11, 14-15 17-18 y.o. Difficulties to sit still in class have mainly 3-8, 11, 17 and 18 y.o

The results for educational outcomes are presented in Table 8.

Table 8. *Results for challenges and coping in terms of educational outcomes*

Educational performance		N	%
Encounters challenges only in some areas	Yes	28	19
	No	120	81
Learning is according to an individual plan	Yes	43	41
	No	61	59
Works cooperatively with other children	Yes	18	12
	No	136	88
Copes with the group tasks	Yes	20	13
	No	137	87

In respect to the educational outcomes it should be noted that only 41% of the respondents have an individual learning plan, and more than half (59%) have no individual schedule, which is likely linked to performance on the indicators

- The majority of the respondents have challenges in more than one area (81%) do not cope with the group tasks (87%), and do not work collaboratively with peers (88%)
- At the same time one tenth of children and students with ASD manage to work cooperatively with peers and cope with the set tasks, and one fifth have challenges only in some areas
- No significant differences were reported by gender and individual learning plan

- 19% of children and students with short-term support, 8% of those with long-term support and none of those without support (14%) worked collaboratively with their peers (χ^2 = 6,291, p = .043; Phi and V = .202; p =.043).
- In terms of working collaboratively with others a significant relationship with diagnosis was accounted, with children with atypical autism (25%) and other pervasive developmental disorders (24%) interacted more than those with ASD with complications (13%) and ASD (7%) (χ^2 = 14.844, p = .005; Phi and V = .310; p = .005). In terms of coping with general tasks the highest percentage of performers were in the group with ASD with complications (25%), followed by other pervasive developmental disorders (17%), ASD (11%), and 0% in atypical autism (χ^2 = 9,693, p = .046; Phi and V = .248; p = .046).
- In respect to age best performed (100%) 15, 18, and 19 y.o. Worst results for cooperative work with peers (0%) had 3-6 y.o., 15 and 17-19 y.o. and best performed 10 y.o. Worst performance with group tasks (0%) have 3, 5, 6, 10, 15, and 17-19 y.o.

The results for social interactions and communication are summarized in Table 9.

Table 9. *Results for challenges and resources in social communication*

Social communication		N	%
Uses inappropriate voice volume/intonation	Yes	81	53
	No	72	57
Makes off-topic comments	Yes	42	29
	No	103	71
Keeps the conversation going	Yes	33	21
	No	124	79
Often changes the subject	Yes	38	26
	No	106	74
Laughs at inappropriate times / rude behaviour	Yes	84	54
	No	72	46
Conscious use of eye contact	Yes	74	47
	No	83	53

For social communication it can be summarized that

- The main challenge is in maintaining a conversation (79%)
- As positive result, equal number of children and students with ASD use appropriate voice volume and intonation, and 47% consciously engage in eye contact
- As a major strength, it can be highlighted also that most children and students with ASD do not tend to change the subject (74%) and do not make off-topic comments (71%)
- No differences were reported for gender and personal support
- Age: most challenges to keep conversation (0%) had 3-6 y.o.

Memorization of instructions and the need instructions to be repeated is presented in Table 10.

Table 10. *Scores for auditory memory challenges and coping*

Auditory memory		N	%
Forgets instructions	Yes	91	62
	No	56	38
Needs constant guidance	Yes	139	88,5
	No	18	11,5

For auditory memory, the results show that

- The main focus should be on the need for constant guidance (accounted for 88.5% of the respondents) as more than half of children and students tend to forget instructions
- However, it shall be noted that 38% of the respondents do not forget and respectively follow the instructions

There were no differences noted for either gender, nor according to the personal support.

Discussions

ASD is a neurodevelopmental impairment characterized by deficits in social communication and the presence of restricted interests and repetitive behaviours (APA, 2013). The heterogeneity of ASD is the object of numerous studies describing specific disturbances. These have been outlined for mental functioning in particular in children (Simonoff et al., 2008) and physical health (Cashin et al., 2018). Ashburner et al. (2010) outline deficits within the mainstream school in terms of emotion regulation and learning. Lifelong development impairments have also been outlined, in professional and social life of adults (Levy and Perry, 2011; Howlin et al., 2013; Schmidt et al., 2015).

Table 11 summarizes the challenges, resources and specificity for the 7 studies areas.

Table 11. *Summarized results*

Functional areas	Challenges	Resources	Specificity
overall language mastery and speech development	lack of speech / unintelligible speech; difficulty in constructing sentences, understanding the meaning in reading difficulties in remembering abstract concepts, new concepts and finding the right word	more than half of the children and students with ASD can imitate sounds and phrases and have grammatically coherent speech, use speech for communicative purposes, and do not merge sounds of the children and students half find the right words, understand abstract concepts and new concepts, cope with sound analysis and synthesis	Ensured support is rather important for positive outcomes Age and diagnosis have also specific effect
thinking	main challenges reported concern the organisational skills and understanding causal relations; more than half of the respondents are unable to apply what they have learned in practice	slightly over one third of the children and students surveyed manage to put the information into practice	Gender, diagnosis and age have to be taken into account
interpersonal interactions	major challenges are observed in emotional regulation, initiating and adequate involvement in social contact, and socially acceptable behaviour	one-third respond appropriately; one-fifth demonstrate socially acceptable behaviour	Ensured support is rather important for positive outcomes Diagnosis and age have specific effect
attention and perceptions	the main challenge for the children and students with ASD is to hold attention and, respectively, to remain sitting still during class, listening and responding to instructions, and lack of mastery of peer behaviour patterns	one-fifth of the respondents are able to learn by role models of peers, listen and respond to instructions; over one-tenth cope to hold their attention for long periods of time	Ensured support is rather important for positive outcomes Diagnosis and age have to be taken into account
educational outcomes	the majority of the respondents have challenges in more than one area, do not cope with the group tasks, and do not work collaboratively with peers	one tenth of children and students with ASD manage to work cooperatively with peers and cope with the set tasks; one fifth have challenges only in some areas	Ensured support is rather important for positive outcomes Diagnosis and age have to be taken into account

Functional areas	Challenges	Resources	Specificity
social communication	the main challenge is in maintaining a conversation	most children and students with ASD do not tend to change the subject and do not make off-topic comments; equal number of children and students with ASD use appropriate voice volume and intonation; half of them consciously engage in eye contact	Some age specificity can be accounted
auditory memory	accounted need for constant guidance, as more than half of children and students tend to forget instructions	38% of the respondents do not forget and respectively follow the instructions	

In reply to RQ1 more common features than differences had been accounted. Important role has the provided additional support. Some specific effects of diagnosis, age, and gender outlined, can be informative what teachers and educators can take into account. This is supported by the ratio of children and students having and not having additional support, which is almost equal.

In reply to RQ2 the results reveal a further implication of the scorecard, which enables teachers and educators in easy and smooth follow-up activities. The instrument and expertise furthermore are supposed to have important role in inclusive setting, empowering users in respect to their expertise and giving indication when and what kind of expertise they can claim.

In reply to RQ3 in can be replicated once again the importance of individual work. The common features, both concerning challenges and resources, lead to the robust conclusion was again. Only taking in account the personal profile, but not relying on and following general indicators, can be beneficial for support of children and students with ASD and their families.

Key areas of challenge, areas of support, and strengths in the general population of children and students with ASD are outlined in our investigation. Irrespective of the difficulties, the fact that at least one tenth of children and students with ASD manage to master language, the auditory memory and self-regulation stand out in all the indicators. Social interaction and task performance are not impaired with appropriate supports.

The main challenges for the children and students with ASD in our analyses are the prevalence of lack of speech, unintelligible speech and difficulties in constructing sentences, understanding the meaning in reading, remembering abstract concepts, new concepts and finding the right word, mastering organisational skills and understanding causal relationships, integrating knowledge into practice, emotional regulation, initiating and adequately engaging in social contact, attention deficits, listening and responding to instructions. The majority of respondents have difficulties in more than one area, are unable to cope with group tasks, and are unable to work collaboratively with their peers.

Notably, most of the children and students with ASD do not tend to change the subject and do not make off-topic comments. Well over half of the children and students with ASD can imitate sounds and phrases and have grammatically coherent speech, use speech for communicative purposes, and do not blend sounds. Half of the respondents use appropriate vocal volume and intonation, and make conscious eye contact. Almost half of the respondents find the right words, understand abstract and novel concepts, and engage in sound analysis and synthesis. One-third of children and students with ASD respond appropriately to social interactions, including remembering and following instructions. One-fifth demonstrate socially acceptable behaviour, are able to learn from peer modelling, listen and respond to directions, and more than one-tenth are able to maintain attention for long periods of time and have challenges in only some areas. One-tenth of children and students with ASD are able to work cooperatively with peers and complete tasks.

In the face of the challenges outlined, especially in recent studies the focus shifted to highlighting the strengths, capacity, and performance of individuals with ASD. In particular, the capacity of attention to detail has been reported (Baron-Cohen et al., 2009). Conclusions reveal further how the difference in information perception and processing leads to coping with tasks given visuospatial information process-

ing and auditory perception (Happe and Frith, 2009; Remington and Fairnie, 2017). Particular attention is drawn to the better auditory discriminative abilities and responses of individuals with ASD compared to typically developing individuals (Remington and Fairnie, 2017), and that research practice should focus on describing different interpretations rather than remaining with a difficulties focus (Grissom et al., 2024). In addition to the direction outlined for a personalized approach, specific educational approaches for individuals with autism have been proposed, including machine learning to increase fidelity in meeting their unique needs (Hajjej et al., 2024), improving performance through building intraverbal skills in adolescents (Karetnikova, *2024*).

ASD appears more frequently in males than in females with a male-female ratio of 4-5:1 (Vicari et al., 2019). There are no significant differences reported by gender, suggesting, contrary to many studies, that difficulties have common specificities across both genders and that when a differentiated complex assessment is used, the similarities rather than differences are highlighted. This is further supported by the significant differences reported in diagnosis and personal support provided. Age also plays a role.

All this suggests that a comprehensive and differentiated assessment can only be adequate to outline a profile of personal development and that setting expectations and limits can have a guiding effect, but only after individualizing the profile of each child/student.

The results replicate the acknowledgement of the difficulties outlined in research on children and students with ASD , mainly in the area of communication and the need for an individualized approach (Bagetti et al., 2023), highlighting the heterogeneity and significant percentage of coping children and students. This also relates to the limited social communication characteristic of ASD (Durkin, 2019), which research also confirms is not straightforward.

Rather, we view the results as confirmation of individualising the approach (Hayden-Evans et al., 2022) and tailoring to individual characteristics [4; 6] and creating an appropriate and relevant learning environment (Bystrova et al., 2017; Shah et al., 2019) and biopsychosocial context (Vallefuoco et al., 2022).

The outlined findings focus on considering all strengths and resources and embedding them in a real inclusive environment where children and students with ASD can flourish (Okoye et al., 2023; Narciso et al., 2024). The findings of this study align with prior international research that utilized the ICF-CY framework to delineate profiles of individuals with Autism Spectrum Disorder (ASD) across various domains of functioning. These results corroborate the conclusions of earlier investigations (e.g., Mahdi et al., 2018; Balsa, 2023, Damyanov, 2024), which underscored the critical importance of individualized assessment and support strategies accounting for contextual and environmental factors. This congruence between theoretical underpinnings and empirical evidence substantiates the utility of the ICF-CY framework in formulating inclusive education plans and long-term support for children and students with ASD.

The main limitation of this study is the disproportion of girls and boys and the different diagnoses and especially the small number of respondents in different age groups. All the differences reported suggest the need for further research. However, the similarities and resources outlined support the conclusion for the specific role of the context and the need to involve and inform a wider range of participants in the inclusive environment. Empowering families, general teachers and children and students with guidelines can promote and support the optimal developmental context for children and students with ASD.

Conclusions

The use of a comprehensive toolkit for optimal individualized profiling of strengths and challenges in the developmental process and interaction with children with ASD is important to facilitate professionals in recognizing and managing their observations in the process of interacting with children with ASD, and can also be used to inform the broader range of those who interact with children and students with ASD in inclusive settings. Awareness of mainstream teachers, peers, and families of the key areas for support and how to facilitate communication can provide a broader supportive framework and understanding of mechanisms for effective interaction, addressed to strengths but not to challenges. The fact that no significant difference by gender emerged in this study is indicative that when considering general indicators of coping, it is the support provided and environmental factors that lead the way. The main focus should be on the need for constant guidance and ensuring supportive context. Children and students with ASD obviously respond adequately to the environment and have no challenges when all we speak the same

language. The main contribution of this study is empowering teachers and educators to have active part along with medical and other professionals in early screening and intervention and promotion of personal development of children and students and the provided universal tool, adapted for their field of expertise.

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Conflict of interests

The authors declare no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Institutional Review Board Statement

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Informed Consent Statement

Informed consent was obtained for all subjects involved in the study.

Author Contributions

Milen Zamfirov - conceptualization, supervision, investigation, writing—original draft preparation, project administration; Margarita Bakracheva - conceptualization, supervision, writing - original draft preparation; Kaloyan Damyanov - conceptualization, supervision, writing - original draft preparation; Lyudmila Filipova Belenska-Todorova - data curation, formal analysis, validation, visualization, writing – review and editing; Polina Daskalova-Petkova - data curation.

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Psychology of the Defendant and his Testimony in Criminal Proceedings

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Abstract: The defendant is the main procedural subject and a party in criminal proceedings. Only a natural person who is procedurally competent to exercise their rights and duties can acquire the status of a defendant in criminal proceedings. The procedural competence of the defendant includes two fundamental characteristics – a certain age and mental health. The defendant's testimony can only be obtained through interrogation. Interrogation of the defendant is an evidentiary action that consists of the defendant's statement regarding the criminal offense he is charged with and falls into the category of personal evidence. The legal side of the defendant's interrogation, which regulates his position and his set of rights and duties, as well as legally defined institutions ensuring equality with the opposing party (i.e., the prosecutor), represents a necessary form and condition for a court decision to be based on such evidence, in accordance with the Criminal Procedure Code. However, aside from its legal dimension, the interrogation also entails psychological aspects. Accordingly, this paper analyzes the position of the defendant in criminal proceedings, as well as the psychological aspects of his participation and testimony before the competent authorities. Considering the rights and obligations of the defendant, the available legal means that ensure procedural equality with the prosecutor, but also the various pressures and mental states the defendant experiences (fear, uncertainty, discomfort, shame, humiliation, etc.), along with his motivation to actively participate in the proceedings, and his ability to remain silent or speak untruthfully, it is evident that the defendant can neither be unmotivated nor uninterested in the outcome of the proceedings. Therefore, it was essential to consider the role and significance of the defendant's psychological functions and personality traits, which considerably influence both his ability to testify and the validity, truthfulness, and credibility of his statement. The paper is methodologically based on a theoretical, primarily desk-based analysis of relevant contemporary views in domestic and foreign theory, normative analysis of current legislative sources, inductive and deductive approaches in research, and descriptive analysis of indicators relevant to the psychology of the defendant and the psychological foundations of his testimony in criminal proceedings.

Keywords: *criminal proceedings, defendant, interrogation, evidentiary action, psychological functions, psychological aspects of testimony formation.*

Introduction

The defendant is a person against whom criminal proceedings have been initiated and are being conducted, due to a founded suspicion that they committed a criminal offense charged in a specific indictment. The defendant's position in criminal proceedings is "particularly interesting, because it involves a person whose rights may be limited (e.g., the right to liberty) or whose property may be diminished (e.g., by the imposition of a monetary fine)" (Mirkov, 2019, p. 162).

The defendant is "a legally independent principal criminal procedure subject and, as such, bears the function of the defense" (Milošević and Stevanović, 1997, p. 142). The literature recognizes the view that "the defendant is a natural person, or exceptionally a legal entity, against whom, at the request of the authorized prosecutor, criminal proceedings are conducted to determine whether a criminal offense was committed and whether conditions exist for the imposition of a criminal sanction" (Brkić, 2014, p. 185),

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as well as the opinion that "the defendant is a person against whom criminal proceedings have been initiated and are conducted, due to a founded suspicion of committing a criminal offense, and represents an independent principal procedural subject, who as such holds the function of the defense" (Stevanović and Stanojević, 2005, p. 90), and that "the term 'defendant' refers to a natural person against whom an authorized prosecutor files and conducts a criminal action, and the court conducts criminal proceedings to determine whether the person is criminally responsible and whether the conditions for imposing an appropriate sanction exist" (Grubač, 2004, p. 190).

According to Article 2, paragraph 1, item 2 of the Criminal Procedure Code, a defendant is a person against whom an indictment has been filed but not yet confirmed, or against whom a criminal charge, private criminal complaint, or motion for the imposition of a security measure of compulsory psychiatric treatment has been submitted, and for whom the main hearing or sentencing session has not yet been scheduled. Additionally, the term is used as a general designation for a suspect, accused, and convicted person. Thus, at first, the Code associates the term "defendant" with the procedural stage in which the person is at the time of the indictment, and later expands the definition to serve as a general term for anyone undergoing criminal prosecution. Therefore, the term "defendant" will refer to a person against whom criminal proceedings are conducted, at all stages and phases.

The defendant is the main procedural subject and a party to the proceedings, "entirely procedurally equal to the authorized prosecutor" (Matijašević, 2024, p. 220). This equality is achieved through the defendant's right to both material and formal defense, and through the presumption of innocence — a fundamental principle that governs the defendant's position in criminal proceedings and stands as a major pillar of the rule of law and a democratic society.

Only a natural person can acquire the status of a defendant in criminal proceedings, and this person must be procedurally competent to exercise their rights and duties. Procedural competence, as with all natural persons, includes two fundamental characteristics: a certain age and mental health.

The issue of age, "as one of the essential characteristics of procedural competence and a fundamental requirement for acquiring the status of a defendant, is regulated by the provisions of substantive criminal law" (Milošević and Stevanović, 1997, p. 142), as well as by the provisions of the Law on Juvenile Criminal Offenders and Criminal Protection of Juveniles. Article 2 of this *lex specialis* defines the age of the offender when the offender is a minor. A minor is considered a person who, at the time of committing the offense, has reached the age of fourteen but has not yet turned eighteen. The law recognizes two categories of minors: younger minors — persons aged between fourteen and sixteen, and older minors — persons aged between sixteen and eighteen. The law also defines the term "young adults" as persons who were eighteen at the time of the offense but not yet twenty-one at the time of trial.

Mental health in criminal proceedings is conditioned by the state of sanity, and two situations are distinguished: the mental health of the defendant at the time of the offense, and at the time the proceedings are initiated and conducted. Criminal responsibility differs between these two. It should be emphasized that there is a presumption of mental health — all individuals, including defendants, are presumed to be mentally sound both at the time of the offense and during the proceedings. If there is any doubt about a defendant's mental state, the criminal court is obliged to determine it through forensic psychiatric evaluation. If it is established that the defendant became mentally ill after committing the offense, the proceedings may be suspended in the case of temporary illness, or terminated in the case of permanent mental illness. If the defendant was mentally ill at the time of the offense, a security measure of compulsory psychiatric treatment and confinement in a health institution or compulsory psychiatric treatment while free may be imposed. Hence, "a person in a state of insanity will not be held criminally responsible for committing the offense" (Perović, 2020, p. 112).

The defendant's statement can only be obtained through interrogation. This evidentiary action consists of the defendant's declaration regarding the alleged criminal offense. Broadly speaking, interrogation serves two purposes: to inform the defendant of the charges and allow him to present his defense (Damaška, 1962).

The defendant is usually the most knowledgeable about how the criminal offense occurred, so "his statement can be very helpful in establishing the factual circumstances. The evidentiary action of interrogation and the defendant's statement remain a complex and current topic in criminal procedure law. While legal aspects are primary, one should not ignore the fact that the notion of testimony originates in general psychology, making its psychological aspect functionally and substantively inseparable from its legal component" (Mirkov, 2019, p. 162).

The mental processes involved in forming testimony, as well as the psychological characteristics of participants, are the subject of forensic and criminal psychology and, together with various criminal law institutes (like legal (in)sanity, *actiones liberae in causa)* form an important bridge between law and psychology. These intersections indicate that no discipline operates in isolation and that multidisciplinary approaches are essential in practice.

The defendant's position is especially interesting because it cannot be equated with any other role in criminal proceedings. For instance, unlike a witness, who might have been a chance observer, or an expert whose knowledge may aid the court, the defendant's position arises from the existence of a certain level of belief that the individual committed the offense. This belief can range throughout the process — from reasonable suspicion to certainty. Given this, along with the psychological pressures (fear, uncertainty, discomfort, shame, humiliation, etc.) and the possibility of remaining silent or giving false statements, it is clear that unlike other participants, the defendant cannot be indifferent or unmotivated about the course or outcome of the trial.

A Brief Overview of the Defendant's Position and the Evidentiary Action of Interrogation in Criminal Proceedings

According to Article 3, paragraph 1 of the Criminal Procedure Code and Article 34, paragraph 3 of the Constitution of the Republic of Serbia, everyone shall be presumed innocent until their guilt for a criminal offense is established by a final court decision.

In legal theory, there are various perspectives on the legal nature of the presumption of innocence — whether it should be understood as one of the fundamental procedural principles, as a right belonging to the defendant as a party to the proceedings, or as a key characteristic of the defendant, such as mental health, age, etc. (Matijašević, 2024). The presumption of innocence is often linked to the principle of *in dubio pro reo*, since both are procedural guarantees that enhance the defendant's position. It is also associated with the principle of contradiction, which "enables the parties to freely and directly present their personal views and arguments on all facts and legal issues in the case" (Matijašević Obradović and Subotin, 2020, p. 36). Accordingly, the procedural effect of the presumption of innocence is that it "eliminates any *a priori* assumption of the defendant's guilt and remains unchanged throughout the criminal proceedings until the final decision of the court" (Jekić, 2003, p. 127). Flower (2020, p. 150) and Nilsson (2021, p. 2) interpret criminal trials as "an interaction between the court and the parties, where each individual must perform their societal role to ensure the process runs smoothly, with professional and lay participants occupying different roles, and the defendant's position being particularly stressful as their guilt is being assessed."

As the main procedural subject, the defendant is equal to the authorized prosecutor and is granted a set of rights and duties that define their procedural position. The basic right of the defendant is the right to defense, which may be material or formal. This right is both statutory and constitutional, guaranteed under Article 33, paragraph 2 of the Constitution of the Republic of Serbia. From this, fundamental right derive other procedural rights listed in Article 68 of the Criminal Procedure Code, such as: To be informed promptly and in a language the defendant understands of the offense charged, the nature and grounds of the accusation, and that any statement made may be used as evidence; To remain silent or refuse to answer particular questions, to present their defense freely, to plead guilty or not guilty; To defend themselves personally or with the assistance of a legal counsel; To have their counsel present during the interrogation; To be brought before a court without delay and tried fairly and within a reasonable time; To review the criminal complaint, investigative reports, and expert findings before the first interrogation; To be given sufficient time and opportunity to prepare a defense; To examine case files and inspect physical evidence; To gather evidence for their defense; To respond to all facts and evidence presented against them and present facts and evidence in their favor; To cross-examine prosecution witnesses and request examination of defense witnesses under the same conditions; To use legal remedies and perform other actions as allowed by the Code.

Article 9 of the Criminal Procedure Code strictly prohibits and penalizes the use of torture, inhumane or degrading treatment, force, threats, coercion, deceit, medical procedures, or any other measures intended to influence the defendant's will or extract a confession or any other statement or act from them or any other participant. In this context, Lach and colleagues emphasize that "national legislators are obliged to adopt

provisions that not only safeguard the rights of the defendant but also adequately protect the rights of others involved, including persons being examined during the criminal proceedings, as such situations can involve secondary victimization and other specific risks and discomforts" (Lach, Klubińska and Badowiec, 2022, p. 1159).

In addition to rights, the defendant, as a procedural subject equal to the prosecutor, also has certain duties. According to Article 70 of the Criminal Procedure Code, the defendant must respond to summonses from authorities and notify the competent authority of any change of address or intent to relocate.

As noted earlier, a defendant's statement can be obtained only through interrogation. This is an essential evidentiary action, as the defendant's statement contains facts that may either support or go against their interests (Matijašević, 2024, p. 327).

The interrogation is conducted only if the defendant is available to the court, i.e., if the trial is held in the defendant's presence. In line with legal provisions, "successful conduct of criminal proceedings requires the presence of certain individuals, primarily the defendant" (Matijašević Obradović and Zarubica, 2018, p. 2). Exceptionally, this evidentiary action will not be conducted if the defendant is not available, and conditions for trial in absentia are met (under Article 381 of the Criminal Procedure Code — trial in absentia is allowed omly if there are strong reasons for it, and if the defendant is in hiding or unavailable to the court, and the panel grants the motion of the prosecutor).

During interrogation, the defendant may take an active approach and provide a statement regarding the alleged criminal offense, or adopt a passive stance and refrain from any statement. "The defendant must be given the opportunity to testify, but whether they exercise this right is solely their decision" (Škulić and Bugarski, 2015, p. 265).

The main goal of interrogation is to allow the defendant to state everything they wish to say about the charges. Only after they have provided a statement may the authorities ask questions to clarify any unclear or contradictory issues.

The defendant is interrogated multiple times throughout the proceedings — during the investigation, at the main hearing before the first-instance court, and at the hearing before the appellate court. Interrogation is conducted by the prosecutor or the court. Exceptionally, under Article 289, paragraphs 4 and 5 of the Code, during the preliminary investigation stage, police may interrogate a suspect under specific conditions. It is important to note that "for a police interrogation of a suspect to be valid, the suspect must consent and give their statement in the presence of legal counsel. The record of this interrogation may be used as evidence, and must be promptly submitted to the prosecutor if the prosecutor was not present" (Škulić and Bugarski, 2015, p. 269).

The interrogation process consists of two parts: (1) The competent authority first establishes the identity of the defendant, informs them of their rights, and cautions them about their legal duties; (2) The second part involves the actual interrogation regarding the criminal event (Bejatović et al., 2013, p. 66).

Once these prerequisites are met, the defendant who wishes to present their defense is further questioned about the alleged crime. The Code also prescribes rules for conducting the interrogation.

According to Article 86, paragraphs 1–3 of the Code, the defendant is interrogated orally, with decency and full respect for their dignity. The defendant has the right to use notes during interrogation. They must be allowed to express themselves freely regarding all incriminating circumstances and to present all facts in their defense. Once the defendant finishes, questions may be posed to supplement or clarify the testimony. Questions must be clear, specific, and comprehensible; they must not be misleading, presume an admission, or suggest answers.

If the defendant later makes statements that differ from earlier ones — especially if they retract a confession — the authorities may, under Article 86, paragraph 4 of the Code, ask them to explain the reasons for the differing statements. If the defendant is deaf, questions are posed in writing; if mute, answers must be written; if blind, written evidence is read aloud. If interrogation cannot be conducted in this manner, an interpreter will be used. If the defendant does not understand the language of the proceedings, questions are translated.

A written record is kept of the interrogation.

In terms of the indictment, there are two primary types of testimony a defendant may give: confession and denial. This only applies if the defendant actively participates — if the defendant remains silent, such a defense is never interpreted as a confession and must be treated as a full denial (Škulić, 2013, p. 211).

Ultimately, the defendant's statement is assessed as any other evidence — according to the principle of free evaluation of evidence and the judge's free belief. The fact that the defendant chose not to testify or answer questions may not be considered an aggravating circumstance or used against them in any evidentiary sense.

The Importance of Applying Scientific Psychological Disciplines in Criminal Proceedings

The defendant's interrogation, as an evidentiary action, belongs to the group of personal evidence, as opposed to material evidence, because the source of information about the contested facts is a human being. The formation of the defendant's testimony, as well as that of other participants (e.g., witnesses), undergoes specific psychological processes that significantly determine the content and value of the statement presented to the authorities as a result of interrogation (or examination, in the case of witnesses). Foreign literature emphasizes the importance of understanding the psychological side of the defendant's behavior and testimony, because the approach of the parties involved "should foster public trust in the criminal justice system while simultaneously ensuring fundamental fairness for the defendant" (Hughes and Khan, 2024, p. 335). It is also important to highlight the role of the defendant's motivation to participate actively in proceedings and to provide a complete testimony. In psychology, "motives are defined as organic or psychological factors that trigger or regulate behavior aimed at achieving certain goals" (Rot, 1977, p. 87). The development of motivation is "a process of initiating, directing, and managing human activity, as motives are connected to goals, interests, and needs. They greatly influence behavior, while the selection of motives also depends on one's internalized value orientations, social attitudes, and character traits" (Nikolić Ristanović and Konstantinović Vilić, 2018, p. 405).

The psychological basis of testimony formation in criminal proceedings is highly complex and involves multiple processes related to perception, comprehension, memory, and reproduction of observed events. Every testimony is formed through these phases, which significantly shape its content and characteristics (Matijević and Marković, 2013, p. 233). The process can be summarized by the formula: P (Perception) + C (Comprehension) + M (Memory) + R (Reproduction) = Testimony

The forensic psychological concept of testimony, according to the controling opinion in legal theory, includes a narrower concept of testimony and a broader concept of testimony. According to the position that prefers a narrower understanding, „defendant's statement is the communication of perceived and remembered facts or facts related to them, which are made by the interrogated persons in criminal proceedings" (Delić, 2011, p. 2). According to the position that emphasizes the broader understanding, "testemony is a statement that is given by any participant of the proceedings in the context of a judicial proceeding in the broadest sense of the word, in the capacity of such a participant, and the statement can refer to any issue that could be significant for the course and outcome of the proceeding" (Aćimović, 1987, p. 205; Aćimović, 1980, p. 35).

The importance of forensic and criminal psychology in criminal proceedings is indisputable. The knowledge provided by these disciplines — especially during evidence gathering and understanding the psychological processes of participants (notably the defendant) — is invaluable. Forensic (or so-called legal) psychology is a scientific psychological discipline whose „subject of study consists of psychological processes and characteristics, as well as their inherent behaviors of participants in court proceedings" (Jekić, 2001). In general, „the subject of study of both forensic and criminal psychology is psychological processes and behaviors, only in the case of forensic psychology, it is the psychological processes and behaviors of the participants in the judicial process (accused, witnesses, injured parties, prosecutor, judge, jury members), while in the case of criminal psychology, it is about the psychological processes and behaviors of the participants in the criminal investigation (suspect, injured party, witness) (Baić and Deljkić, 2019, pp. 11-12).

Some foreign scholars argue that "the utility of forensic and criminal psychology techniques in criminal trials still requires research — including whether such techniques benefit or hinder the careers of legal professionals or outcomes for their clients" (Wilson, 2019, p. 4). Other authors note the lack of research into whether psychological techniques have a negative or positive impact on lawyers, officials, or even psychologists themselves, particularly in terms of effects on the defendants (Kim, Becker-Cohen and Serakos, 2015; Spaulding, Cook and Avila, 2014; Wexler, 2013; Winick, 2013). Nevertheless, the growing role of forensic and criminal psychology is evident both in Serbia and internationally, especially in the domain of therapeutic jurisprudence — when defendants are addicts or persons with substance use disorders. It is said that "the insensitivity of the regular judicial system toward individuals suffering from drug or alcohol addiction has catalyzed the development of therapeutic justice in comparative law, aiming to improve rehabilitation and reduce recidivism in criminal proceedings" (Tešović, 2024, p. 135).

Methodology and Source of Research Data

The subject of analysis in this paper is the position of the defendant in criminal proceedings, along with the psychological aspects of his behavior and testimony before the competent procedural authorities.

As previously emphasized in the introduction, the defendant's role in criminal proceedings is particularly interesting, as it cannot be equated with that of any other procedural participant. Considering the rights and obligations of the defendant, the available legal instruments that ensure procedural equality with the opposing party — i.e., the public prosecutor — as well as the various pressures and states the defendant experiences (fear, uncertainty, discomfort, shame, humiliation, etc.), together with his motivation to actively participate in the proceedings and the option to remain silent or be untruthful, it is clear that, unlike other primary or secondary procedural actors, the defendant cannot be indifferent or unmotivated about the course of the proceedings, nor uninterested in its final outcome.

The paper is methodologically based on: Theoretical,primarily desk analysis of relevant contemporary positions in both domestic and international literature; Normative analysis of current legislative sources; Inductive and deductive approaches to research; Descriptive analysis of relevant indicators concerning the psychology of the defendant and the psychological foundations of their testimony in criminal proceedings.

The Psychology of the Defendant and the Psychological Foundations of the Defendant's Testimony in Criminal Proceedings

From the perspective of criminal procedure and criminalistics, the proper assessment of the truthfulness of testimonies by procedural subjects — as personal sources of evidence — is of great importance. The reliability of such personal evidence (e.g., the defendant's interrogation or a witness's examination) is evaluated, on the one hand, by comparing it with other established evidence and testimonies (and, if necessary, by conducting confrontations with co-defendants or other witnesses), and on the other hand, through the application of various psychological techniques and expertise. Knowledge of the psychology of testimony is, therefore, a highly valuable tool, given the complexity of the psychological foundations involved in the formation of testimony.

Accordingly, a defendant's testimony may be classified as truthful or untruthful. A truthful testimony is complete, objective, and corresponds to the factual situation or actual event. An untruthful testimony may be either unintentionally false (i.e., mistaken) or intentionally false (i.e., a lie).

To understand the psychology of the defendant and their testimony, it is important to analyze both: Psychological functions or mental processes involved in the production of testimony, Psychological traits or personality characteristics (e.g., temperament, character, abilities, interests, needs, attitudes, etc.).

The mental processes involved in the testimony of a procedural subject (obtained through interrogation or examination) are outlined in the following table:

Table 1. *Mental Functions (Processes) Underlying Testimony of the Procedural Subject as a Personal Source of Evidence*

Mental Functions (Processes)			
	Cognitive (Intellectual) Functions	Conative (Volitional) Function	Other Mental Functions
1.	Memory	Drives (Motives)	Attention
2.	Perception	Emotions	Consciousness
3.	Thinking	Will	
4.	Intelligence		

Source: Mirkov, 2016; Baić and Deljkić, 2019

Perception is a complex mental function and the "first psychological function in the formation of testimony" (Mirkov, 2016, p. 287). It is defined as "a complex mental process that begins when a sensory organ registers a stimulus, which then travels from the specific sensory organ to areas of the cerebral cortex, where it is transformed into a sensation" (Milovanović, 2005, p. 29). The reliability of perception can be

compromised during testimony "due to the selective nature of perception, logical mechanisms of completion, and the influence of personal attitudes, desires, and prejudices" (Golubović, Lakić and Ilić, 2002, p. 57).

Building upon perception, attention plays a vital role in other mental processes — especially in memory — and is characterized by alertness (vigilance) and concentration (tenacity). Modern cognitive psychology emphasizes the "multi-layered nature of attention, distinguishing between visual and auditory attention, as well as attention in perceptual information processing, cognitive control, and response generation" (Anderson, 2015; Baić and Deljkić, 2019, p. 66). The main properties of attention are: span, intensity, selectivity, direction, and mobility. Testimony reliability may be impaired by attention disorders — specifically in vigilance or tenacity — often manifesting as distractibility, or aprosexia, which some authors define as a lack of concentration.

Memory is a mental function "that participates in the creation of testimony and arises in conjunction with perception, expression, thinking, and other mental traits and personality characteristics" (Aćimović, 1987; Mirkov, 2016, p. 294). It is believed that "a defendant who has clearly remembered the circumstances of the offense can effectively recall possible evidence, witnesses, and relevant facts, thereby being able to refute the charges or at least influence their legal qualification" (Mirkov, 2016, p. 296). Memory is the brain's ability to store and retrieve information (Golubović, Lakić and Ilić, 2002, p. 58). As Mirkov (2016, p. 294) explains, memory is composed of five elements, listed in the following table:

Table 2. *Elements of Memory Involved in the Formation of Testimony*

Elements of Memory		
First element	Fixation (registration of an engram)	The initial phase in the process of memory, characterized by the ability to retain certain material in the form of an engram. This ability has its organic and physiological basis — it is the moment of concentration of the senses and consciousness for the fixation of the stimulus that is to become the object of awareness.
Second element	Retention	A key element in the memory process, because that which was not previously retained in consciousness cannot later be recognized, nor reproduced.
Third element	Evocation	The exertion of intellectual effort to "recall" what was perceived and what one wishes to reproduce. It can be intentional or spontaneous. From the perspective of our topic, intentional evocation is particularly important, because during the interrogation, the defendant is always reminded of the circumstances of the accusation, which requires him to recall an event from the past. Intentional evocation is even more pronounced during the questioning of the defendant.
Forth element	Recognition	In the chronology of the process, it could be said to be a phase, but one that does not necessarily precede reproduction and may even occur without evocation. Recognition is most commonly present in communication and represents incomplete memory or incomplete presentation of well-remembered content.
Fifth element	Reproduction	It represents the part of memory process that enables the preservation of the past without renewed perception of the information. Reproduction is the restoration of content in full and in the order in which it was experienced and remembered, and is the true and best evidence of memory. Interrogations of parties are conducted more often at the level of recognition, while the presentation of facts and data — especially in the context of giving a confession — for the purpose of establishing evidence of guilt, should be conducted on the basis of reproduction.

Source: Mirkov, 2016, pp. 294-295; Kostić, 2000, pp. 70-73; Marić and Lukić, 1998, p. 28; Ćirić and Dimitrijević, 2009, p. 32

Testimony reliability can be compromised by memory disorders, such as amnesia, hypomnesia, hypermnesia, or transient forgetfulness, caused either organically or by fatigue, emotional states, or excitement.

Thinking as a mental activity represents the directed shaping of signs and symbols in order to come to an understanding of relationships and connections between phenomena (Rot, 2010) and is undoubtedly the most complex psychological process, which is actually the link between all other psychological processes that participate in the creation of statements and unifies them into a whole. Therefore, it can be said that thinking is "a mental function by which a person, using thought operations, perceives the real relationships between objects and phenomena and draws appropriate conclusions based on that" (Marić and Lukić, 1998, p. 34). The literature mentions "individual experience, intelligence, motives, certain emotional processes" as factors that are important for the thinking process (Delić, 2008, p. 47). The credibility of statements can be compromised if a person has thought disorders that manifest themselves in several

ways: "verbosity (statements is not separated from the irrelevant); slowness of the flow of thought (speech is drawn out and slowed down, and the impulse to speak is reduced); block in thought (sudden interruption of the continuity of the thought process and interruption of the presentation of the started thought); incoherent thinking (the connection between the expressed thoughts is deficient); crazy ideas (thought contents that are unrealistic, illogical, absurd and unacceptable for the environment), obsessions or obsessive ideas (thoughts that forcefully appear in a person's mind, against their will); overestimated ideas (contents that have real significance in a person's life, but are excessively emphasized and exaggerated)" (Baić and Deljkić, 2019, p. 78).

In criminal proceedings, various individuals appear, each with their own interests, motives, reasons, and characteristics, which must be taken into account when planning and conducting the interrogation of the defendant and the examination of witnesses. Therefore, "the examination of the personality of the defendant is often of crucial importance for making the correct decision regarding which criminal sanction to impose on the perpetrator of a criminal offense" (Drakić, 2014, p. 253). In line with this, special attention should be given to the intelligence and drives, i.e., the motives of the defendant in criminal proceedings. Namely, intelligence is a significant personality trait and is defined as a person's ability to recognize facts, their relations to objects and phenomena, acquire new knowledge, and solve problems, whereas drives (motives) are actually impulses that prompt a person to pursue their own interests. Taking into account the situation in which the defendant may find themselves during criminal proceedings, their intelligence and motivation to participate in the process and refute, either wholly or partially, the allegations made against them, the aforementioned psychological functions may be "a significant factor in the conduct of their defense." It should be noted that an intelligent defendant carefully prepares the commission of a criminal offense, strives not to leave any traces behind, nor to retain any items related to the crime, and as a result, the available evidence concerning the commission of the offense is usually less abundant. When it comes to the interrogation of the defendant, their ability to perceive essential connections in the examiner's questions becomes apparent, along with their skill in identifying what the examiner is seeking to discover and what is concealed as important within those questions. Thus, the defendant can easily avoid giving the answer the examiner seeks or may present certain facts differently — facts which, in the absence of other evidence, may lead the procedural authority to harbor doubt regarding the existence of certain circumstances" (Mirkov, 2016, p. 304). The credibility of the testimony may be compromised if the person exhibits certain quantitative or qualitative disorders in drives, i.e., motives, or displays tendencies toward specific reactive states that may fall into the category of temporary mental disturbances affecting intelligence as a psychological function.

Finally, the importance of emotions (as a subjective reflection of the human psyche towards to the stimuli from the outside world), will (as a function that is essentially related to drives) and consciousness (as the highest psychological process that establishes, synchronizes and controls the development of the human psyche as a whole) as psychological functions, which are very complex and can significantly determine the attitude of the accused and his role in the criminal proceedings, should be emphasized.

By studying the psychology of the defendant and his testimony in criminal proceedings, it can be concluded that various processes at the level of cognitive, affective, and behavioral functioning determine the specific psychological traits and characteristics of each individual. What must be taken into account during the interrogation of the defendant in criminal proceedings, as well as during the assessment of the truthfulness and credibility of his testimony, is certainly his psychological vulnerability, which "refers to the psychological characteristics or mental states of a person that, in certain cases, influence personal sources to provide inaccurate, unreliable, and incorrect information" (Gudjonsson, 2003; Meissner and Russano, 2003; Baić and Deljkić, 2019, p. 106). Four forms of psychological vulnerability are distinguished and are presented in the following table.

Table 3. *Forms of Psychological Vulnerability of the Defendant in Criminal Proceedings*

Psychological Vulnerability			
Mental Disorders	Abnormal Mental States	Intellectual Functioning	Personality Characteristics
1. Mentar illnesses	1. Anxiety	1. Inability to understand questions	1. Suggestibility
2. Learning disorders	2. Panic attacks	2. Inability to respond	2. Complience
3. Pesonality disorders	3. Phobias	3. Inability to comprehend the significance of the interrogation	3. Tacit agreement

Source: Gudjonsson, 2003; Gudjonsson, 2003

It is evident that these forms of psychological vulnerability significantly affect both the defendant's ability to testify and the validity, truthfulness, and credibility of the testimony itself.

Conclusion

The defendant is the principal procedural subject and a party in criminal proceedings. Only a natural person who is procedurally competent to exercise their rights and duties may acquire the status of a defendant. Procedural competence, like that of natural persons in general, is determined by two basic conditions — a certain age and mental health.

As stated in the paper, the defendant's testimony can only be obtained through interrogation. The interrogation is an evidentiary action consisting of the defendant's statement regarding the criminal offense they are charged with, and it belongs to the category of personal evidence.

The importance of the defendant's interrogation as an evidentiary action is not only reflected in its undeniable practical relevance, but also in the fact that it is placed first among evidentiary actions in the Criminal Procedure Code of the Republic of Serbia. The legal aspects of interrogation — including the regulation of the defendant's position, the scope of rights and duties, and the institutional framework ensuring equality with the opposing party, i.e., the prosecutor — represent an essential form and condition for the court to base its decision on such evidence. However, beyond its legal dimension, the interrogation also has significant psychological implications.

Accordingly, the subject of this paper is the position of the defendant in criminal proceedings, as well as the psychological aspects of his participation and testimony before the competent authorities. This research may contribute to the unification of approaches to assessing defendants' statements by integrating the legal provisions of the Criminal Procedure Code of the Republic of Serbia with established models of psychological vulnerability and memory formation. Accordingly, future empirical research could be aimed at quantitatively assessing the correlation between the psychological functions on which the testimony of a criminal subject is based, and the psychological vulnerabilities that significantly affect both the defendant's ability to give his or her testimony, as well as the validity, truthfulness, and credibility of the testimony itself, in relation to the rate of false confessions or refusal to give testimony to judicial authorities. What could also be the subject of further research is how often psychological factors that influence the formation of the defendant's statement are taken into account and how they are interpreted in the reasoning of the court verdict.

Given the defendant's rights and obligations in the proceedings, the legal instruments that ensure procedural equality with the prosecutor, and the array of psychological pressures and emotional states the defendant undergoes (fear, uncertainty, discomfort, shame, humiliation, etc.), as well as the defendant's motivation to actively participate in the process and the option to remain silent or even to speak untruthfully — all of these point to the fact that, unlike other primary or secondary procedural subjects, the defendant cannot be indifferent or unmotivated with regard to the proceedings, nor uninterested in the final outcome.

Therefore, it was important to examine the role and influence of the defendant's psychological functions and personality traits, which significantly affect both the capacity of the defendant to provide testimony and the validity, truthfulness, and credibility of that testimony.

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Between Progress and Peril: The Role of Artificial Intelligence (AI) in Shaping Modern Political Communication

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Abstract: Since artificial intelligence (AI) has been integrated into our digital communication landscape, there have been major changes in how political campaigns are strategically designed and how public opinion is influenced. With the help of machine learning (ML), generative models (GM) and natural language processing (NLP), AI tools have introduced new opportunities for political engagement. Today, thanks to AI-driven data analytics, we can micro-target voters based on their psychographic profiles and adapt political messages with incredible precision. On the other hand, generative AI technologies are increasingly used to spread false information or to imitate political endorsements, which has a great impact on public opinion. The dissemination of such content can greatly reinforce ideological prejudices and contribute to social divisions. This paper draws on recent empirical research and case studies to illustrate how AI-generated disinformation campaigns can affect electoral processes and undermine trust in democratic institutions. Various examples, such as the use of bots to control social media to deepfake content impersonating political figures, show that ethical, technological and legal safeguards are urgently needed. Furthermore, this paper supports an approach to AI governance that strikes a balance between promoting innovation and reducing harm. This implies the development of tools for AI detection, transparency measures and cooperation between sectors in order to promote responsibility and integrity of information. Greater digital literacy among citizens and proactive policy responses will be necessary in the near future to ensure the resilience of democratic systems due to the increasingly rapid development of AI technology.

Keywords: *Artificial Intelligence (AI), Political Communication, Generative AI, Deepfakes, Disinformation, Large Language Models (LLMs).*

Introduction

According to Fetzer and Fetzer (1990), artificial intelligence (AI) is the ability of computers to imitate human intelligence and to think and learn in the same ways as human beings. The impact of AI, due to its rapid development, is becoming greater in numerous fields, especially in politics. The rise of digital technology has brought a host of highly complex challenges to the sharing, reliability and consumption of political information. This shift prompts a careful examination of the role of AI in political communication and highlights the need for strategies that promote greater transparency and, in our digital age, foster informed public discussions (Bareis and Katzenbach, 2022).

The acceptance of cultural values and public opinion are greatly influenced by the media, many of which are deceptively promoted as independent ideas (Baltezarević et al., 2014). However, the rise of new technologies is increasingly suppressing traditional cultural values and narratives, often replacing them with algorithmically generated content (Baltezarević et al., 2019). AI has revolutionized the way we analyze extensive data sets, including demographic, behavioral, and psychological data derived from individuals' online behaviors, as well as the growing issue of deepfakes (Chester and Montgomery, 2017). These tools are often used to create persuasive political messages (Carr, 2011).The emergence of "deepfakes," that is, realistic fake videos produced through AI-based facial manipulation, has raised social alarms due to their

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ability to imitate a person's actions or speech with minimal signs of manipulation (Chawla, 2019).

Alexander Nix (the former CEO of Cambridge Analytica) mentioned that by understanding the psychological characteristics of target audiences, political communications can be adjusted to connect with specific traits, be it emotional, rational, or fear-driven (Mermoud, 2017). Large language models (LLMs) are typically fine-tuned to boost user engagement by spotting patterns that create emotionally resonant and engaging content (Ethayarajh et al., 2024). A focus on engagement can often amplify controversial narratives, as people tend to connect with content that is consistent with their beliefs (Brady et al., 2017).

More than half of Americans voiced serious concerns about the spread of AI-generated political propaganda, according to a 2023 survey, while 23% were only moderately concerned (Statista Research Department, 2024). These worries are not unfounded, as there have already been several reports of AI being abused in political communication. For instance, the founder of the investigative website Bellingcat, Eliot Higgins, created fake photos of Donald Trump's arrest using the Midjourney AI platform, and the German political party AfD used AI-generated graphics to inflame anti-refugee sentiment (Matheis, 2023).

According to a recent survey, social media is one of the main sources of news for 56% of respondents, but almost 70% of them believe that it is also the largest source of false information, raising serious questions about its reliability (Weforum, 2024). This dynamic, with the advent of generative artificial intelligence (GenAI), only adds to the complexity. GenAI systems can both create and identify fake content (Loth et al., 2024). For example, OpenAI's GPT models are able to produce content that closely resembles the style, tone, and structure of reliable news sources, making it difficult to distinguish between authentic journalism and made-up stories (Brown et al., 2020).

To tackle this challenge, technology and human oversight must collaborate. Large language models (LLMs) can indeed spread false information, but they also have the potential to help us fight against it (assuming we implement human intervention effectively). It's vital for users, content moderators, and news organizations to take proactive measures to curb the dissemination of misleading information. Reporting questionable content can enhance AI detection systems and help quickly identify harmful or deceptive information (Virginia Tech, 2024).

On a broader level, AI has significant implications for democratic processes. The ability of AI to create misleading information, influence voter behavior, and potentially undermine election integrity is a major concern (Coeckelbergh, 2022). Yu, 2024 in their study highlights the necessity of finding a balance between robust regulatory measures, technological advancements, and ethical oversight to mitigate these risks. With the potential to distort political realities and threaten democratic institutions, deepfakes and AI-generated misinformation are among the most pressing threats to the integrity of elections.

Ultimately, it's essential to reflect on the ethical implications and the potential of AI technologies as they advance. Since AI is still in the early days of development, continuous research, development, and critical evaluation are key to solving current issues and shaping the future of this technology in a way that bolsters democratic processes instead of undermining them (Baltezarević and Baltezarević, 2024).

In order to explore this dynamic more thoroughly, this paper is guided by the following research questions:

1. In what way does artificial intelligence (AI) influence and change strategies in the field of political communication in modern democratic societies?
2. How does AI-powered voter profiling influence the shaping of public opinion?
3. What ethical and legal issues emerge from the political use of deepfakes and AI-generated misinformation?
4. How do AI algorithms lead to political polarization on social media by creating filter bubbles and echo chambers?
5. What legal and technological measures can be implemented to minimize the dangers of AI misuse while still upholding free speech and democratic values?

The Role of AI in Political Communication, Campaign Strategy, and Public Opinion Manipulation

AI is defined as any computer or algorithm that can observe its surroundings, learn from them, and make smart decisions based on that knowledge. This definition is quite expansive and includes a variety of technologies, but machine learning (ML) techniques are currently some of the most popular approaches (Samoili et al., 2020).

AI is dramatically changing the way politicians connect with the public and shape opinions. Its abil-

ity to analyze complex data, process information, and adjust communication strategies based on user preferences makes it a game-changer in modern politics (Crawford, 2021). One of the key applications of AI in this field is data-driven voter profiling, where potential voters are linked to personality types through AI-powered analytics. When we classify personality types using psychographic and demographic factors, we can make informed predictions about how people will respond to different stimuli. This skill gives campaigns a crucial advantage, helping them to sway swing voters and inspire their target audience to participate in elections (Wakefield, 2019).

To make sense of the huge amounts of data flowing from social media and online platforms, politicians are increasingly turning to AI-based analytics to get a clearer picture of what voters really think and feel (Battista and Uva, 2023). This growing reliance on AI tools is enhancing election campaigns and communication strategies, making them more targeted and effective (Alvarez et al., 2023). AI also allows for real-time monitoring of public sentiment on political issues, debates, and candidates. Campaigns can leverage this data to identify potential voters and tailor personalized ads that either encourage or discourage them from voting. Consequently, political leaders can adjust their positions and communication strategies to keep up with the constantly shifting landscape of online public opinion (Lutkevich and Hildreth, 2022).

AI is revolutionizing campaign management by not only boosting financial contributions but also enhancing how messages are crafted. A striking example of this is the "Vote Leave" campaign during the Brexit referendum, which cleverly used A/B testing to tailor their messages for specific demographic segments. Campaign director Dominic Cummings explained that the catchphrase "Let's take back control" was deeply rooted in a careful analysis of public opinion on the European Union (EU). Through their iterative testing, they found that the word "back" in the slogan sparked anger by triggering loss aversion, the psychological tendency to prefer avoiding losses over acquiring equivalent gains, especially when it comes to control (Schneider, 2017).

To more effectively reach and engage their target voters, candidates and their campaign staff can harness the predictive power of AI by combining data from a variety of sources (Crilley, 2018). This capability allows for the development of highly customized political messages that resonate with voters' unique needs and preferences, enhancing the campaign's overall impact (Nunziata, 2021). The use of AI is growing rapidly, especially for real-time fact-checking and analyzing public reactions to political events. For example, Microsoft's AffectiveSpotlight employs head movements and facial expressions to assess viewers' emotional responses, allowing presenters to tweak their delivery style (Murali et al., 2021).

Political debates can benefit greatly from AudienceView, which uses large language models (LLMs) to classify audience feedback, thus directly helping journalists better understand public opinion (Brannon et al., 2024). In addition to this system, Factiverse and Full Fact are real-time fact-checking websites that have introduced AI systems capable of capturing, evaluating, and analyzing political commentary in real time (Corney et al., 2024). A billion web pages may seem impossible to scan. However, Factiverse is making it feasible for both companies and individuals to extract the information they require into essential, easily assimilated insights using intelligent prioritization and robust crawling tools (Factiverse, 2025). Full Fact is a British nonprofit that verifies and corrects news reports and statements that make the rounds on social media (Dudfield, 2025). Full Fact AI uses cutting-edge artificial intelligence to enable fact checkers, journalists, researchers, and communicators to recognise, validate, and refute misleading content (Fullfact, 2025).

AI's impact stretches far beyond just campaigning; it's also leaving its mark on governance. One of the standout advantages is its knack for sifting through massive amounts of data to predict the outcomes of political decisions. AI has also changed how people communicate with their representatives, introducing fascinating new features like chatbots and virtual assistants on company websites and AI-powered social media interactions. This has opened up more direct communication channels between elected officials and the people they represent (Viudes, 2023). Still, there are some risks to consider. For instance, during the 2025 protests in Los Angeles, AI chatbots such as Grok and ChatGPT were found to spread false information because they misinterpreted images and lacked the necessary context (Gilbert, 2025).

AI chatbots can provide voters with tailored insights about candidates and policies, which can boost participation and support informed decision-making (Political Communication, 2023). However, the rise of AI-generated content, including deepfakes and synthetic media, poses a serious risk to the integrity of political communication (Thornhill, 2024). These tools can be misused to spread false information, influence public opinion, and erode trust in democratic institutions, particularly in nations with lower media literacy levels (Funk et al., 2023). To truly harness the benefits of AI, it's essential for governments, civil

society, and tech companies to collaborate and create strategies that are specifically designed for different contexts (Hagerty and Rubinov, 2019).

We tend to underestimate the importance of improving our digital literacy, especially given the threats posed by deepfakes and AI-generated disinformation. The speed at which synthetic media is evolving is outpacing our technology and legal systems. Encouraging media literacy and critical thinking skills has become a more effective and scalable way to address these problems. Recent research shows that digital literacy programs can successfully reduce people's vulnerability to false information by improving their ability to spot content that is manipulative and better understand how certain narratives are promoted by algorithmic systems (Guess et al., 2020). It is also crucial that both governments and digital platforms work together to promote public education through accessible initiatives, such as media warnings, verified fact-checking labels, and very clear explanations of algorithms (Roozenbeek and van der Linden, 2020). Even the most sophisticated detection technologies can become useless if there is no widespread digital literacy, as end users remain vulnerable to emotionally charged synthetic content (Sustainability Directory, 2025).

AI-driven bots have become quite common on social media platforms. Typically powered by ML algorithms, these bots can imitate human behavior at an impressive speed while still appearing genuine. They use natural pauses and responses to create the illusion that a human is behind the messages (Bessi and Ferrara, 2016). Any government or political party with enough financial backing can deploy a whole army of social bots to influence public discussions on social media, removing the need for specialized technical skills and resources (Ferrara et al., 2016).

While these technologies can enhance social interactions and deepen our understanding of one another, they also come with risks like deceit, manipulation, and the spread of misinformation (Gallo et al., 2022). The influence of social bots is amplified by how easy they are to create and manage. Social bots often take on tasks such as researching hashtags and keywords, posting content, responding to user interactions, following users interested in specific topics, and gathering opinions on online discussions (Ferrara et al., 2016). The misinformation generated by AI, especially the biased or fake news produced by advanced text generation systems, could seriously undermine political engagement and pose a threat to democratic processes (Klinger et al., 2023).

We can theoretically distinguish between "good" and "bad" social bots. Bad (malicious) bots usually spread harmful links or misleading stories, while good bots share posts that offer valuable information. Bad bots often create fake accounts that look almost identical to real users, making it tough to differentiate them from trustworthy content. As noted by BSI (2025), these bots typically engage in coordinated "fake news" efforts that seek to shape public opinion. Pamment et al. (2018) highlight that this dishonest strategy can significantly impact political backing and alter our perception of reality in multiple ways.

The growing presence of bots is only widening the gap in society, creating confusion, and shaking public trust in information. This makes it increasingly tough to tell what's real and what's not (Bradshaw and Howard, 2018). For the first time in over ten years, automated traffic has overtaken human internet usage, making up almost 51% of all web traffic, as highlighted in the 2025 Imperva Bad Bot Report. The surge is mainly driven by large language models (LLMs) and the swift rollout of AI technology (Chang, 2025).

AI is revolutionizing fields such as speech and sentiment analysis, as well as content creation and distribution. To grasp the emotional tone and reactions of the public, political campaigns can use sophisticated algorithms that analyze speeches and communications, helping them detect how audiences are feeling (Khare, 2023). Sentiment analysis is a vital part of natural language processing (NLP) and categorizes emotional content in text as neutral, negative, or positive (based on subjective data) (Rajashekhargouda, 2022). This analytical approach improves business intelligence and provides measurable insights that can improve strategic decisions (Kumar and Garg, 2020). Sentiment analysis models can reveal the polarity of opinions, the topics being discussed, and the individuals behind them (Obot et al., 2025).

AI is also influencing social media influencer marketing strategies outside of the political campaign space. Technologies created by a number of advertising agencies assess an influencer's "brand safety" and forecast whether or not they will participate in political discourse. A marketing company called Captiv8, which works with companies like Kraft Heinz, for example, recently introduced an AI-powered tool that analyses social media users' online mentions to determine how likely they are to discuss elections or other politically sensitive topics. In this system, an "A" means you should exercise extreme caution, while a "C" suggests a profile that's generally safe. Influencers receive these letter ratings based on their writing, comments, and how they're covered in the media. These ratings consider delicate matters like hate speech,

violence, sexual content, and divisive social issues (Maheshwari, 2024).

Artificial Deception: The Crisis of Democratic Integrity, Deepfakes, and Disinformation

The rise of AI brings with it some crucial ethical dilemmas, particularly around the accessibility and transparency of information (Nida-Rumelin and Weidenfeld, 2019). With AI technologies impacting every facet of how we produce and share information, these challenges are becoming more pressing in our rapidly changing digital world. One of the most concerning issues we are facing is the rise in deepfakes. This not only threatens the integrity of our political systems but also puts our society's trust and stability at risk (Westerlund, 2019).

Deepfakes are made by combining deep learning techniques with altered content. This technology creates a deceptive reality that can be difficult to detect with just a glance, allowing a person's face to convincingly express emotions or say things they've never actually uttered (Korshunov, 2018). Thorough training, the generator (Generative Adversarial Networks - GANs), enhances its ability to create more realistic fake images, driven by the competitive dynamics of the system (Shen, 2018). This has resulted to deepfakes becoming increasingly intricate and more difficult to spot.

A diverse array of groups, including governments, political activists, criminals, dubious individuals, conspiracy theorists, and automated bots, are leveraging deepfakes to achieve their goals. According to Zannettou (2019), these objectives can differ greatly, ranging from influencing public sentiment and inciting social chaos to seeking financial gain and demonstrating ideological loyalty. In the political arena, deepfakes are particularly worrisome. They can produce fake videos of people appearing to say or do things they never actually did. This can confuse voters and might even change the course of elections. Such manipulation is a serious threat to democracy, as it prevents individuals from making well-informed choices (Cheguri, 2023).

We must also be aware of the ways these technologies can be misused, such as in financial fraud, scams, hoaxes, fake news, non-consensual pornography, extortion, harassment, bullying, electoral interference, and the spread of disinformation. However, although deepfakes are often viewed negatively, they can actually be quite innovative and beneficial. They have the potential to vividly reenact historical events, enhancing the authenticity of films or serving as useful educational resources (Cruci, 2024). With the rapid advancement of deepfake creation methods and the development of AI detection tools to counter these risks, it's more important than ever for people to learn how to identify misleading media (Appel and Prietzel, 2022). The very AI technologies that make it possible to produce convincing deepfakes also power the tools used to identify them, resulting in a dynamic and ever-changing battleground between creators and defenders. However, this leads to an ongoing technological arms race.

The public's trust in reliable sources of information and organizations has really taken a hit due to these changes. Deepfakes, being trickier to spot than traditional fake news, only add to the cybersecurity challenges that both individuals and organizations face. Plus, since deepfakes blur the lines between reality and fiction, they often have a stronger impact on shaping public opinion (Hu et al., 2022). For instance, Google Trends data reveals that searches for "free voice cloning software" skyrocketed by an astonishing 120% from July 2023 to 2024 (Cruz, 2024), highlighting how accessible technology has made it for even amateurs to create altered audio recordings.

Deepfakes are captivating and novel, which helps them spread false information at lightning speed. Studies indicate that the top 1% of rumors usually don't get more than 1,000 views on platforms like Twitter (now X). In fact, even true news stories tend to have a smaller reach, illustrating how misinformation can travel faster and further than the truth (Vosoughi et al., 2018). To make things even trickier, the technology behind deepfakes is advancing at a pace that outstrips our current detection methods (Surfshark, 2025).

It's difficult to overlook the impact that AI and deepfakes are having on elections. A 2024 survey found that more than 75% of people globally are anxious about AI's potential impact on future elections. The United States and Singapore are particularly concerned, with 72% and 83% of respondents, respectively, voicing their worries (Petrosyan, 2025). Furthermore, large language models (LLMs) and AI tools like Midjourney, Google's Gemini, and OpenAI's ChatGPT have made it easier to normalize deepfakes across multiple platforms (Zandt, 2024).

According to data collected since 2017, 31% of deepfake cases have involved fraud, with particular focus areas being celebrities, and political figures. The targeting landscape shows that 35% of incidents were aimed at politicians or celebrities, while a significant 65% impacted the general public. Of these in-

stances, 27% were politically provocative, and 25% contained explicit content. US President Donald Trump was the most affected, being the target of 18% of the deepfakes involving politicians, which amounts to 25 incidents. Joe Biden faced 20 deepfakes, including voice robocalls that were manipulated and often linked to election matters. Additionally, well-known politicians like Kamala Harris and Volodymyr Zelenskyy also experienced multiple attacks (Surfshark, 2025).

Additionally, large companies are becoming more susceptible to crimes made possible by deepfakes. For example, using a deepfake impersonation of the CFO of the British engineering company Arup, fraudsters were able to successfully transfer $25 million to Hong Kong bank accounts in 2024. The scam was confirmed by the deceitful CFO and team members who participated in video calls (Noto, 2024). Another significant case occurred in 2019, when fraudsters used a deepfake voice of the president of a UK energy company to siphon off €220,000 (Somers, 2020).

A low-tech deepfake video that purported to show American politician Nancy Pelosi intoxicated went viral in 2019, deceiving many Facebook users with almost 2.5 million views (CBS News, 2019). Globally, political deepfakes have become more complex. In early 2024, robocalls featuring a deepfake voice of President Biden were sent to thousands of voters in New Hampshire, discouraging them from voting in the primary election. The fact that these audio recordings were created in less than 20 minutes for just $1 each shows how readily and affordably such false information may propagate (Seitz-Wald, 2024). During the 2023 annual news conference with Russian President Vladimir Putin, a student from St. Petersburg caught everyone's attention by asking a question. What made this moment particularly striking was the use of deepfake technology. The voice and appearance of this individual were actually created using a deepfake AI avatar of Putin himself (NBC News, 2023).

European laws could serve as a useful blueprint for tackling the issue of false information generated by AI. The EU's Digital Services Act requires tech platforms to evaluate the risks their products pose to society, particularly concerning democracy and elections. Moreover, these platforms are required to provide relevant data to independent experts to help evaluate their impacts (Hetrick, 2024). As policymakers around the world tackle the rapidly changing landscape of AI technologies, these regulatory frameworks are working to find a balance between the risks and rewards associated with AI.

On a global scale, we're starting to see legislative measures take shape in response to these challenges. To boost transparency, the European Union's AI Act of 2024 requires that AI-generated content be clearly labelled. At the same time, several states in the US have enacted laws that make it illegal to create and distribute harmful deepfakes, particularly those intended to influence elections or spread misinformation (Kumar, 2025).

Regulating AI in political communication raises a number of legal concerns, particularly with regard to platform liability, foreign jurisdiction, and the tension between free speech and censorship. The European Union's AI Act and Digital Services Act (DSA) aim to regulate AI use and hold online platforms accountable (European Parliament, 2022). These laws prohibit the use of manipulative AI and also require platforms to eliminate illegal or harmful content, like hate speech and misinformation, by specific deadlines (European Commission, 2021). Although these strategies are designed to protect users, critics warn that they might lead to the over-removal of lawful content, which could violate free speech rights (Lazaro Cabrera, 2024).

With the rise of deepfakes, misinformation, often referred to as "fake news", has become alarmingly prevalent on social media in recent years. This trend has had a profound effect on our economy, politics, democracy, and society as a whole (Burkhardt, 2017). Fake news is often fueled by financial or political motives aimed at influencing public opinion on divisive topics, and it typically leads to serious real-world repercussions (Barclay, 2018). Major digital platforms often come under criticism for not being clear about how they make their decisions. They have a significant duty to manage content and reduce the spread of harmful or misleading information (Gorwa, 2019). This lack of transparency can confuse users, as they wonder why certain posts are taken down while other harmful content stays up, making it difficult to hold anyone responsible (Roberts, 2019).

The lack of transparency in algorithmic content curation and moderation policies raises some serious concerns about inconsistent enforcement and potential bias, especially during politically charged moments (Citron and Pasquale, 2019). While a few platforms have made strides to bring in third-party auditors and share transparency reports, these efforts often fall short of fully explaining the processes behind content moderation and appeals (Gillespie, 2018). This gap highlights important ethical and legal dilemmas about how to balance preventing harm with protecting free speech, as well as who really holds the responsibility

for overseeing the vast expanse of online content (Suzor, 2019).

AI algorithms tend to favor content that ramps up user engagement, often leading to the amplification of divisive or sensational topics, which only deepens the political divide. By shutting users off from a variety of perspectives and reinforcing their existing biases, these AI-powered recommendation systems create echo chambers and filter bubbles (Islam et al., 2024). Echo chambers are particularly common on social media platforms, where users are mostly exposed to information that aligns with their beliefs. This not only reinforces their deeply held convictions but also makes it increasingly difficult for them to accept differing opinions (Jiang et al., 2021). Although the phrase "echo chamber" does not appear often in political science literature, it is frequently used in the context of digital media studies. It illustrates how individuals with like-minded opinions come together online, getting constant reinforcement that can skew their understanding of reality and stifle genuine dialogue (Parry, 2006). Algorithmically personalized environments, often referred to as "filter bubbles," present significant challenges to democracy. These bubbles create separate realities instead of fostering the shared truths necessary for informed participation in a democratic society, as they limit users' exposure to diverse opinions. Such personalization reinforces preexisting biases and desires by protecting people from information that challenges their beliefs, much like subtle propaganda (Populismstudies, 2018).

Global data highlights troubling trends in how people perceive news bias and the spread of misleading information, contributing to what's been dubbed the "infodemic." Roughly 60% of people worldwide say that most individuals only embrace information that backs up their own beliefs. This is particularly noticeable in countries such as the US (68%), Turkey (69%), Serbia (70%), and Peru (71%). What's intriguing is that while 65% of respondents feel that people are actively hunting for opinions that reinforce their views, only 34% admit to feeling stuck in an informational bubble (Konopliov, 2024). The power of this issue is highlighted by the fact that over 70% of Europeans often encounter fake news (Watson, 2024).

The influence of fake news touches every corner of society, affecting how people, groups, and governments respond to the false information that spreads like wildfire on social media. Much of this misinformation is crafted to target specific demographics, aiming to stir up conflict and strengthen ideological backing (Tandoc et al., 2018). In the US, political memes and viral videos are everywhere, often featuring altered images, clips taken out of context, and even portraits created by AI. A couple of striking examples include videos of Taylor Swift and Vice President Kamala Harris impersonating Donald Trump and seemingly endorsing him (Bond, 2024).

AI has really changed the game when it comes to creating fake news. Large Language Models (LLMs) can churn out a ton of readable and coherent content, thanks to their training on massive datasets. Plus, with rapid video generators like Sora, which can create detailed, Hollywood-style fake clips, the spread and impact of misinformation have only grown (Virginia Tech, 2024). To tackle this problem, AI models like Grover have been developed specifically to spot AI-generated fake news, and this approach has shown to be quite effective (Zellers et al., 2019). It analyses the text and structure of articles to find bias, inaccurate information, or other warning indicators using a combination of generation and detection strategies. For separating machine-generated news from human-written news, Grover claims an accuracy of above 92% (Gillham, 2025).

Discussion

The rapid advancement of artificial intelligence (AI) is changing politics and fundamentally altering how democracies function in the modern world. With tools like generative models, deepfake, and innovative content curation algorithms, we could see a surge in political participation, quicker communication, and more tailored interactions between citizens and their leaders. As campaigns get better at fine-tuning their messages, we could see a boost in voter turnout and overall democratic participation. Ideally, these innovations could revitalize democratic processes by making political conversations more accessible, dynamic, and aligned with the unique concerns of citizens.

The exciting potential of technology comes with some serious and complex risks that could undermine social cohesion and the integrity of our democracy. The negative aspects of this technological shift are starkly illustrated by deepfakes and AI-generated disinformation. Unlike simple text-based lies, deepfakes create realistic videos of real individuals making false or misleading statements. These can be

weaponized to attack opponents, suppress voter turnout, or increase social tensions, potentially destabilizing entire electoral processes. The political implications are severe. This kind of manipulation poses a significant threat to democracy, especially given how quickly and easily it can spread, as evidenced by deepfake robocalls aimed at voters or viral videos that misrepresent politicians.

Beyond just deepfakes, the polarization and division in public discourse are getting worse thanks to the widespread use of AI-driven content recommendation algorithms on social media. These algorithms tend to create echo chambers and filter bubbles by prioritizing content that boosts user engagement, which often means sensational, emotionally charged, or extreme ideological content. When users are cut off from opposing viewpoints, it only reinforces confirmation bias and intensifies political tribalism. This lack of common ground undermines the democratic dialogue and compromise we need, as it solidifies partisan rifts and diminishes faith in democratic institutions. Moreover, the worldwide spread of false information, often referred to as an "infodemic," adds to the challenge by sowing doubt about which news and information we can actually trust.

Furthermore, there's a concerted effort to regulate AI and deepfakes. The European Union is taking the lead in this area, working on comprehensive regulatory frameworks that impose responsibility, transparency, and content moderation on digital platforms. Key examples include the AI Act and the Digital Services Act (DSA). These laws require the identification of AI-generated content, mandate risk assessments, and ensure that harmful content is removed quickly, which are all crucial steps toward protecting democratic discourse. Despite the complex challenges at play, it's hard to say just how effective these restrictions will be. To begin with, politicians often struggle to keep pace with the rapid evolution of technology. On top of that, the global nature of the internet complicates jurisdiction enforcement, and the ongoing debates about free speech, censorship, and platform responsibility create tough moral dilemmas. Critics warn that overly broad regulations might hinder free expression, while too little oversight could allow misinformation to thrive.

On a more profound level, however, the phenomenon The Washington Post refers to as the "liar's dividend" is the increasingly prevalent practice of politicians claiming that compromising statements or videos were produced artificially (either by deepfake technology or other AI tools) when there is no supporting evidence (Verma and De Vynck, 2024). This approach sets a concerning precedent by leveraging uncertainty around the accuracy of digital content to dodge accountability. It muddles the line between manipulation and the actual truth. This trend sparks major concerns regarding democracy and social responsibility, as it diminishes the trust that is so important for meaningful discussions in the public sphere. Even when the information is accurate, people struggle to make informed choices if everything is labelled as potentially fake. This also gives those in power the ability to alter the truth without facing any consequences.

Keeping up with technological advancements is crucial in the battle against AI-driven misinformation. AI detection tools are getting better at spotting and flagging fake media. We really need to boost public awareness about AI-generated content and foster critical thinking to help people resist manipulation. Additionally, by putting transparency measures in place, like better content moderation disclosures, we can build more public trust and accountability.

The way societies tackle the ethical, legal, and technological challenges posed by AI will ultimately shape its impact on political communication and the integrity of democracy. We need to encourage collaborative governance frameworks that bring together governments, tech companies, academia, civil society, and the public to set guidelines and standards for ethical AI use. To find the right balance between fostering innovation and upholding essential democratic values like accountability, transparency, freedom of expression, and human rights, we need a strategy that involves multiple stakeholders. Rather than diminishing democratic participation, AI has the potential to enhance it, provided we integrate ethical considerations and maintain strict oversight in its development and application.

Conclusion

In conclusion, we must acknowledge AI's impressive potential to transform political communication and improve democratic engagement. However, we also need to be mindful of the serious threats posed by deepfakes and AI-driven misinformation campaigns to the future of this technology. It's essential that we take prompt action to combat the erosion of trust in information, the increasing social divides, and the

flaws in our electoral systems. Strong laws, advanced technology, public awareness, and global cooperation are vital for democracies to mitigate these risks and safeguard the integrity of their political institutions. The decisions we make today about AI regulation will either uphold the foundational principles of democracy or allow for manipulative technology that diminishes informed public engagement.

It's crucial for future research to dive deeper into interdisciplinary solutions that blend ethical AI design, media literacy education, and inclusive governance frameworks. Scholars, educators, policymakers, and tech developers need to join forces to create evidence-based strategies that strengthen civic resilience and safeguard democratic discourse. By nurturing a culture of transparency, critical thinking, and accountability in technology, we can ensure that AI serves as a tool for empowering democracy instead of causing disruption. The relationship between AI and politics is quite complex, and it requires our continuous joint efforts. We need to work together to nurture the intellectual and democratic development of future generations.

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Author Contributions

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First time: Yan, G., Tian, H., Bai, X. & Rayner, K. (2006). found ...

Second time: Yan, G.et al. (2006) found ... (ibid, p. 12)

• When a work has no author's name, whether it's because it is issued by the agency, organization, or governmental institutions, rather than the names of authors mention the name of the institution or organization that has signed the paper, and if a name is long, just so many words or abbreviation as needed to locate the source in the list of references.

First time: (National Institute of Mental Health [NIMH], 1999) ...
Second time: (NIMH, 1999) ...

• When you do not have the names of institutions or authors, when the work is anonymous, then mention only the first few words of the title, and we quote them in parentheses under the quotation marks

in plain text in italics.

These result present (‘’ Study Finds, ‘’ 2002) ...

The book College Bound Seniors (2003) ...

When work in the header nominated as anonymous, then it in the text under the anonymous quote and cite year, in English (Anonymous, 2011).

• If there are two references to the same author’s last name, then be sure to mention when citing the initials to avoid unnecessary search in a list of references.

JM Goldberg and Neff (1961) and ME Goldberg and Wurtz (1972) studied ...

• If the same author or the same authors cite two or more references, then in brackets do not repeat names but just add a year for the next release.

Past research (Edeline & Weinberger, 1991, 1993) ...

Past research (Gogel, 1984, 1990) ...

• When the same author we have more work during one year, then these sources labeled the letters of the alphabet a, b, c and so on.

Several studies (Gogel, 1984, 1990a, 1990b) ...

• When several authors cite in the same bracket, or when we point to the consent of the author, references detach semicolon and listed them in alphabetical order.

Several studies (Balda 1980, Kamil 1988, Pepperberg & Funk, 1990) ...

• If with some of the references cite a source that confirms what is specific to this reference, then the source listed below see also, but that goes with the source of reference, but not alphabetically.

Several studies (Minor 2001; see also Adams, 1999; Storandt, 1997) ...

• When quoting hearsay, cite the author’s name and year of the original work, followed by a semicolon and then cited code, then last name, year and foreign labor from which he quoted original work.
The first definition of intrinsic motivation gave Decy (1975; see Suzić 2005, p. 108) ...

• If we know the year of the first publication of the work, then it is to be connected age translation by first listed year of first publication, a slash and then year translation.

(James, 1890/1983)

• For an Internet source that does not have a bookmarked Web page, use a pair of ¶ and paragraph number on the page where it was published.

(Myers, 2000, ¶ 5)

• Personal communication or publicly spoken words in a lecture to quote only in plain text, but not in the list of references, but does mention the date of actual communication.

Decy (personal communication, April 18, 2001) ...

REFERENCES

• Form Guidance papers in the journal is as follows:

The author's name [comma], initial / names [point], [open small brackets] year of publication [close little brackets] [point] title of the paper [point], the name of the magazine - in italics [comma] the number or volume - in italics [comma] page starting work [line] Page completing work [point].

Dennis, TA, Cole, PM, Wiggins, CN, Cohen, LH & Zalewsky, M. (2009). The functional organization of preschool-age children's emotion expressions and actions in challenging situations. *Emotion, 9,* 520-530.

• Form quoting the works of authors of books is as follows:

The author's name [comma], initial / names [point], [open small brackets] year of publication [close little brackets] [point] title deeds - in italics [point], the city (and state) [two counts], the publisher [Point].

Hirsch, Jr., E. D. (1996). *The schools we need and why we do not have them*. New York: Doubleday.

• When you mention a paper published in a journal or as part of a book as a chapter, then applies the following form:

The author's name [comma], initial / names [point], [open small brackets] year of publication [close little brackets] [point] title of the paper [point], In Proceedings ... (note that the work was published in a journal or book ...) The name of the publisher [open small brackets] Issue. (Note that this is a publisher) [Close little brackets] [comma] title of the collection - in italics [open small brackets] page starting work [line] Page completing work [point], the city (and state) [two counts], publisher [point].

Barrett, KC, & Campos, JJ (1987). Perspectives on emotional development: II. A functionalist approaches to emotions. In Osofsky JD (Ed.), *Handbook of Infant Development* (2nd ed., Pp. 555-578). Oxford, England: Wiley.

• If seven or more authors, then we will list the names of the six authors, and the seventh and the rest fall into the category of '' and associates ''.

Adam, JJ, Paas, F. Teeken, JC van Loon, EM, Van Boxtel, MPJ, Houx, PJ, et al. (1998). Effects of age on performance and a finger-precuing task. *Journal of Experimental Psychology: Human Perception and Performance, 24*, pp. 870-883.

Second and last author in a list of references are always stating afterward conjunctions & English.

• In magazines published articles cite the following form:

the author's name [comma], initial / names [point], [open small brackets] day, month and year of publication [close little brackets] and the title [point], the name of the magazine or newspaper - italics [comma], number of journals or Newspapers - italics [comma], page beginning of the text [line] Page completing the text [point].

Henry, W. A., III. (1990, April 9). Beyond the Melting Pot. Time, 135, 28-31.

• When we need to with the title of the article mention what kind of material it is then enclosed in square brackets after the title of the paper is printed by it is a brochure, video recording and the like.

Research and Training Center on Independent Living. (1993). Guidelines for reporting and writing about people with disabilities (4th ed.) [Brochure]. Lawrence, KS: Author.

• The work of famous authors downloaded electronically applies the following form:

The author's name [comma], initial / names [point], [open small brackets] year of publication [close little brackets] [point] title of the paper [point], an indication of what kind of material is in square brackets,

taken (note that work will take) the day, month and year, with (internet address).

Schwarzer, R. (1989). Statistics software for meta-analysis [Computer software and manual]. Retrieved March 23, 2001, http://www.yorku.ca/faculty/academic/schwarze/meta_e.htm

• When the list reference is made to the work that is being prepared for the press, after the authors' names, in parentheses, listed in the press in English.

Zuckerman, M. Kieffer, SC (in press). Race differences in faceism: Does facial prominence imply dominance? Journal of Personality and Social Psychology.

• When the list of references cites a newspaper article without the author prints the name of the article, then the time of publication, then the title and number - in italics, and at the end of the page on which the article was published. If the title is long, we can shorten the optimum number of words by taking the first few words.

The new health-care lexicon. (1983, August / September). Copy Editor, 4, 1-2.

• If within the journal as publisher publishes a special issue as a monograph, it is necessary after heading indicate that it is a monograph.

Ganster, DC, Schaubroeck, J. Sime, WE, & Myers, BT (1991). The nomological validity of the Type A personality among employed adults [Monograph]. *Journal of Applied Psychology, 76,* 143-168.

• When an abstract or summary of the quote as the original source, after the title should be in parentheses to indicate that it is abstract.

Woolf, NJ, Young, SL, Famselow, MS, & Butcher, LL (1991). Map-2 expression in cholinoceptive pyramidal cells of rodent cortex and hippocampus is altered by Pavlovian conditioning [Abstract]. *Society for Neuroscience Abstracts, 17*, 480 harvesters.

• Titles that are not in English, and we want them to be published in the journal in English, listed in their native language, and then in the square brackets give the title translation into English. In addition to the title, everything else remains the mother tongue.

Ising, M. (2000). Intensitätsabhängigkeit evozierter Potenzial their EEG: Sindh impulsive persons Augmenter stage Reducer? [Intensuty dependence and event related EEG potentials: Are impulsive individuals augmenters or reducers?]. *Zeitschrift für Différentiel und diagnostisch Psychology, 21*, 208-217.

• In the list of literature translated work following a text that we have a year of the original edition listed in parentheses at the end behind the publisher. When we quote in plain text, year of first publication and translation writing along with a slash between (eg. Laplace, 1814/1951).

Laplace, P. S. (1951). A philosophical essay on probabilities (FW Troscott & FL Emory, Trans.). New York: Dover. (Original work published 1814)

• When the list of references cites a paper published in the Proceedings of the translated, italics will print the name of the collection at the end to add when it published the original.

Freud, S. (1961). The ego and the id. In J. Strachey (Ed. & Trans.), The standard edition of the complete psychological works of Sigmund Freud (Vol. 19, pp. 3-66). London: Hogarth Press. (Original work published 1923).

• When you cite articles published on the university or one of the official institutions, universities, publishers listed as the first name of the university and then university.

Broadhurst, RG, & Maller, RA (1991). Sex offending and recidivism (Tech. Rep. No. 3). Nedlands: University of Western Australia, Crime Research Center.

• When the list of sources cites a report of an organization or institution that has no author, it is best to nominate as the author of this organization, which is also the publisher.

Employee Benefit Research Institute. (1992, February). Sources of health insurance and characteristics of the uninsured (Issue Brief No. 123). Washington, DC: Author.

• When the work was published on the Internet as a photocopy, it should cite the original source noting that this is the electronic version.

Vandenbos, G. Knapp, S., & Doe, J. (2001). The role of reference elements in the selection of resources by psychology undergraduates [Electronic version]. Journal of Bibliographic Research, 5, 117-123.

• If you download from the Internet work that you believe is different from the original, do not copy or no numbered pages, then at the end indicate the date of downloads and web address.

Vandenbos, G. Knapp, S., & Doe, J. (2001). The role of reference elements in the selection of resources by psychology undergraduates [Electronic version]. Journal of Bibliographic Research, 5, 117-123. Retrieved October 13, 2001, from http://jbr.org/articles.html

• When you download from the Internet a document which has no date or author, then the document name takes the place of the author or the first place.

8th GVU's WWW User Survey. (Od). Retrieved August 8, 2000, from http://www.cc.gatech.edu/gvu/user_surveys/survey-1997-10/

• Material from the symposium or a scientific paper which was only exposed, but not published, listed with the note on which the scientific or professional meeting is material exposed. If the author has presented on the site, it is desirable to name and web page.

Cuter, LD, Frölich, B., & Hanrahan, P. (1997, January 16). Twohanded direct manipulation on the responsive workbench. Paper presented at the 1997 Symposium on Interactive 3D Graphics. Abstract retrieved June 12, 2000, from http://www.graphics.standard.edu/papers/twohanded/

• Computer software listed noting computer software. Name of the software we write italics.

Miller, M. E. (1993). The Interactive Tester (Version 4.0) [Computer software]. Weastminster, CA: Psytek Sesvice.

• Data downloaded from the website of the government or other official organization listed noting data file. The filename of the data listed in italics.

Department of Health and Human Services, National Center for Health Statistics. (1991). National Health Provider Inventory: Home health agencies and hospices, 1991. [Data file]. Available from the National Technical Information Service Web site, http://www.ntis.gov

Standards take according to Suzic, N. (2010). *Pravila pisanja naučnog rada APA i drugi standardi* [Rules scientific APA work and other standards]. XBS Banja Luka.

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The journal has a standard template – IJCRSEE template. To cite reference, it is the easiest way to use some management software like:

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Above management software have plug-ins to word processing where authors only need to select the appropriate journal template when preparing their article and the list of references and citations to these will be formatted according to the journal style as described in this Guide. If you cannot find an available template, see the list of sample references and citations provided in this Guide to help you format these according to the journal style.

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International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE) would like to acknowledge the following reviewers for their assistance with peer review of manuscripts for issues in 2024. Their comments and suggestions were of great help to the authors in improving the quality of their papers. Each of the reviewers listed below returned at least one review for these issues.

Thank you Reviewers!

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